

Exhibit 9

CONFIDENTIAL

NEW REAGENT SYSTEMS -

PLANT TRIAL AT

WINDSOR MINERALS INC.

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INTRODUCTION:

Windsor Minerals has been actively engaged in a froth floatation research program for the past year and a half. This program has developed two floatation reagent systems which offer substantial advantages to the Windsor floatation process from an economic, purity and potential health hazard point of view.

In the absence of known deleterious effects attributable to these reagent systems and in response to the favorable results in testing performed by Baby Products Research in New Brunswick, Windsor Minerals scheduled a plant trial as a guide for establishment of the product and process parameters under actual operating conditions.

The plant trial was conducted on January 29, 1974. During this trial cosmetic grade talcs were produced using both new reagent systems, i.e., n-butyl alcohol and n-butyl alcohol-citric acid in combination.

The following report will deal with the product and process parameters of the trial as determined by Windsor Minerals and outside consultants.

CONCLUSIONS

1. A reduction in total acid soluble materials was attributable to the new reagent systems. The magnitude of the reduction was 23% for n-butanol and 28% for n-butanol-citric acid.
2. A similar decrease in "magnesite" levels was effected. The decrease was 23% using n-butanol and 30% for the n-butanol-citric acid combination.
3. A color (reflectance) increase of 1.0 units was effected while using n-butanol; an increase of 1.4 units was attributed to the n-butanol-citric acid system.
4. Chrysotile fiber suppression was indicated while using the n-butanol-citric acid system.
5. Talc recoveries were higher while using the new reagent systems. The increases were 17% for n-butanol and 19% for n-butanol-citric acid.
6. The chlorite content of the floated product was reduced 14% while using n-butanol and 15% while using n-butanol-citric acid.
7. A substantial decrease in the bulk density of the product was noted while using the new reagent systems. The decreases were 2.06 lb/ft³ and 2.82 lb/ft³ respectively for the n-butanol and n-butanol-citric acid systems, corresponding to decreases on a percentage basis of 8.4% and 13.0%.

8. The platy nature of the talc product was found to be unchanged by the use of the new reagent systems.
9. The pH of n-butanol-citric acid floated talc was significantly closer to neutrality than current production. The decrease in alkalinity was measured to be 1.25 pH units for material made during the plant trial.
10. Particle size distribution profiles were similar for materials floated with Ultrawet D.S., n-butanol, and n-butanol-citric acid.
11. Optical microscopy indicates a high degree of similarity with relation to the size and shape factors of materials produced during the plant trial.

Minor differences were noted with respect to talc shards and rolled edges. The product differences, however, correspond quite closely with differences found in the ores from which the products were beneficiated.

OPERATIONAL DESCRIPTION

At 4:30 AM on January 29, 1974, immediately prior to the plant trial using the n-butanol based reagent systems, 1000 pounds of Ultrawet D.S. floated talc was collected and packaged in 4 fiber drums. At the same time a representative ore sample was collected. These materials were used as a reference for the plant trial products.

The floatation circuit was then purged for 3 hours to remove the residual Ultrawet, after which n-butyl alcohol was added at a rate of 1.08 liters per ton of floatation feed.

Sampling was begun after 30 minutes and continued on a 30 minute basis thereafter. The samples were immediately analyzed by the Windsor Minerals Q.A. Laboratory.

After establishing that equilibrium conditions had been reached in the floatation circuitry a 1000 pound sample of finished product was taken and stored in fiber drums for further studies.

Following collection of the n-butanol floated product, citric acid was added to the circuit at a rate of 4 pounds of citric acid per ton of floatation feed, while maintaining the n-butanol additions as before. When the circuit was judged to have reached equilibrium conditions based upon the analytical results, another 1000 pound sample of finished product was taken and stored in fiber drums, also for future studies. 0.2%

SAMPLING

Production sampling for quality assurance purposes was begun at 9:30 AM on 1/29/74 and continued at half hour intervals for the duration of the plant trial. The following table lists the materials sampled and the analyses performed during the trial.

Table 1 Quality Assurance Analytical Schedule

<u>Material Sampled</u>	<u>Sample Qty.</u>	<u>% Acid Insolu- bles</u>	<u>Color Reflec- tance</u>	<u>pH</u>	<u>-325 Mesh Screen</u>	<u>Bulk Density</u>	<u>% Mag- nesite</u>
Ore	500g	X	X		X		
Tailings	250cc	X					
Cleaner Concentrate	500cc	X	X	X			
Product	500g	X	X	X	X	X	X

Composite ore and tailings samples were collected 30 minutes prior to and during each product collection. A product composite for each reagent system used was also obtained from the material packaged in fiber drums.

The composites were then used for the development of analytical data for comparative purposes in assessing the effects of the reagent systems upon the process and resulting products.

EXPERIMENTAL & RESULTS

Table 2 displays a compilation of Quality Assurance data obtained during the test run. The results were used for circuit control, establishment of operational parameters, and talc recovery calculations.

Product composite samples representing materials made with Ultra-wet D.S., n-butanol and n-butanol-citric acid were analyzed in accordance with our standard certification procedures. These results, in the form of a standard laboratory report are given in Tables 3, 4 and 5. The data in these tables confirms that the new reagent systems provide substantially improved products in the following categories:

1. total acid solubles
2. magnesite
3. color
4. bulk density
5. pH

There were no specification categories in which a decrease in product qualities were observed.

Table 6 provides the trial results in terms of talc recovery.

Talc recovery was calculated using the relationship:

$$\% \text{ Recovery} = 100 \frac{(H-T)}{(C-T)} \times \frac{C}{H}$$

where:

H = % acid insoluble content of ore

T = % acid insoluble content of tailings

C = % acid insoluble content of cleaner concentrate

Recoveries were derived by obtaining mean acid insoluble values for ore, tailings, and cleaner concentrates from Table 2 for the time period during which the specified reagent was used. These values were compared to the 8 hour production shift immediately preceding the reagent trial during which time Ultrawet D.S. was the floatation reagent. It is apparent from Table 6 that a substantially higher recovery is afforded by the use of n-butanol based floatation systems.

Particle size measurements were performed by two methods; sedimentation velocity using the Andreasen Sedimentation Pipette and by actual optical measurement using the TMC Image Analyzing system. The results are given in Tables 7-12 and graphically displayed in Figures 1-9.

The particle size distribution profiles indicate the similarity of the products within the framework of the technique used for measurement. However, we have noted and confirmed that differences between the techniques and the values obtained via the techniques do exist. It has been our experience that the direct measurement of particle size and shape which is possible with the Image Analyzing method is a superior determination to the indirect measurements made by the sedimentation method.

On this basis, potential benefit is indicated in that the optical measuring technique has verified a lower fine particle content reporting in the finished product when using the alcohol based systems, particularly the n-butanol-citric acid system. This fact has been confirmed by Walter C. McCrone Associates who have reported the same conclusions based on their optical studies.

Mineralogical examinations for detection of amphiboles were performed by Dr. R. Reynolds at Dartmouth College on the composite ore and product samples. The results for the Ultrawet D.S., n-butanol and n-butanol-citric acid floated products are given in Table 13 and Attachment C, titled "Mineralogy of Ores, Product and Mill Tails Re Different Floatation Reagents".

There were no significant differences with respect to the amphibole content in the test products. The detected amphibole minerals did not appear in a fibrous form in any of the product samples.

Mineralogical analyses using X-ray diffraction techniques were performed on the composite ore, tailings and talc products during each segment of the reagent trial periods. This work was performed by Dr. Reynolds; the results are given in Table 14 and Figure 10.

The gross mineralogical content of the three ore samples were essentially the same.

Analysis of the finished products by X-ray techniques indicate a substantial reduction in chlorite content attributable to the alcohol based systems.

Analysis of the tailings resulting from the use of the three different reagent systems by X-ray diffraction identifies a profound difference in the mineralogical composition. As shown in Figure 10, talc peaks in the alcohol based system tails are roughly one tenth the intensity as found in the Ultrawet system tails. Optical microscopic examination of the tailing fractions from the alcohol based systems also indicates that the small quantity of talc present is essentially all a blocky or non-platy variety. These results confirm the substantial talc recovery differences between the Ultrawet and n-butanol based systems which had been independently determined by chemical analyses.

Asbestiform analyses were performed by Walter C. McCrone Associates by means of transmission electron microscopy and electron diffraction techniques. Their report is found in attachment "A". An abstract of their findings is given in Table 15. Quantitative treatment of these results is questionable due to the extremely low chrysotile levels present, however depression of chrysotile through the use of citric acid in combination with n-butanol is indicated. To better quantify the depressive affects of citric acid upon magnesium surfaced asbestiforms, Attachment "B" titled "Asbestiform depression through the use of new floatation reagent systems" is included to provide details of an earlier study in this area.

SUMMARY & REMARKS

The results of the plant trials using n-butanol and n-butanol-citric acid reagent systems as compared to the presently used Ultrawet D.S. system has indicated a marked superiority of these new systems.

The use of citric acid in the depression of chrysotile asbestos and other mineral species has been developed at Windsor Minerals in response to the potential need for a means to exclude extremely low levels of these contaminants from the finished product of the beneficiation process. } *note?*

The use of these systems is strongly urged by this writer, to provide the protection against what are currently considered to be

materials presenting a severe health hazard and are potentially present in all talc ores in use at this time.

In closing, based on Windsor's knowledge of the physical chemistry of talc, and upon the results of all work performed to date, it is our strong belief that the use of these new reagent systems will not alter the salient consumer properties of the raw material supply or the finished baby powder sold under the Johnson and Johnson name.



Vernon Zeitz
Manager, Research and Development
Windsor Minerals Inc.
5/14/74

QUALITY ASSURANCE SAMPLING TEST RESULTS

TIME	SAMPLE DESIGNATION	ACID INSOLUBLES (%)	COLOR REFLECTANCE (%)	pH	-325 m SCREEN (%)	BULK DENSITY (lb./ft. ³)	MAGNESIT (%)
9:30	ORE	58.98	73.4		90.93		
	TAILINGS	28.32					
	CLEANER CONCENTRATE	99.05	88.0	7.57			
	PRODUCT	99.08	87.2	8.06	89.07	24.61	.54
10:00	ORE	62.15	73.8		90.40		
	TAILINGS	25.84					
	CLEANER CONCENTRATE	98.94	87.3	7.78			
	PRODUCT	99.18	87.4	7.92	90.47	23.93	.54
10:30	ORE	64.80	74.6		90.05		
	TAILINGS	24.95					
	CLEANER CONCENTRATE	98.94	87.1	7.79			
	PRODUCT	98.83	87.3	7.92	89.70	23.20	.58
11:00	ORE	61.62	74.8		90.09		
	TAILINGS	26.26					
	CLEANER CONCENTRATE	98.80	87.3	7.81			
	PRODUCT	98.85	87.0	7.99	89.93	23.34	.64
11:30	ORE	65.79	74.8		89.86		
	TAILINGS	26.40					
	CLEANER CONCENTRATE	98.76	87.2	8.42			
	PRODUCT	98.86	87.4	8.44	89.45	23.04	.71
12:00	ORE	65.02	74.4		90.38		
	TAILINGS	28.86					
	CLEANER CONCENTRATE	98.97	87.3	8.19			
	PRODUCT	98.75	87.2	8.10	90.47	22.63	.71

TIME	SAMPLE DESIGNATION	ACID INSOLUBLES (%)	COLOR REFLECTANCE (%)	pH	-325 m SCREEN (%)	BULK DENSITY (lb./ft. ³)	MAGNESITE (%)
12:30	ORE	66.28	74.0		89.15		
	TAILINGS	24.13					
	CLEANER CONCENTRATE	98.54	86.3	8.19			
	PRODUCT	98.60	86.7	8.10	88.92	23.32	.64
13:00	ORE	63.67	75.0		90.10		
	TAILINGS	28.82					
	CLEANER CONCENTRATE	98.49	86.4	7.89			
	PRODUCT	98.40	86.4	7.81	90.84	22.10	.71
13:30	ORE	64.27	75.3		90.01		
	TAILINGS	23.37					
	CLEANER CONCENTRATE	98.56	86.9	6.38			
	PRODUCT	98.47	87.2	7.42	91.22	21.30	.71
14:00	ORE	61.17	75.3		90.66		
	TAILINGS	26.05					
	CLEANER CONCENTRATE	98.78	87.3	5.28			
	PRODUCT	98.67	87.3	7.01	91.29	21.11	.59
14:30	ORE	57.96	75.3		89.92		
	TAILINGS	24.27					
	CLEANER CONCENTRATE	98.67	87.1	4.64			
	PRODUCT	98.52	87.2	7.22	90.01	21.41	.61
15:00	ORE	61.42	75.2		89.62		
	TAILINGS	23.69					
	CLEANER CONCENTRATE	98.69	87.5	4.38			
	PRODUCT	98.54	87.2	7.10	91.59	21.37	.57

TIME	SAMPLE DESIGNATION	ACID INSOLUBLES (%)	COLOR REFLECTANCE (%)	pH	-325 m SCREEN (%)	BULK DENSITY (lb./ft. ³)	MAGNESIUM (%)
15:30	ORE	62.63	75.2		89.75		
	TAILINGS	22.38					
	CLEANER CONCENTRATE	98.86	87.9	4.38			
	PRODUCT	98.66	87.5	6.92	90.37	21.56	.53
	ORE						
	TAILINGS						
	CLEANER CONCENTRATE						
	PRODUCT						
	ORE						
	TAILINGS						
	CLEANER CONCENTRATE						
	PRODUCT						
	ORE						
	TAILINGS						
	CLEANER CONCENTRATE						
	PRODUCT						
	ORE						
	TAILINGS						
	CLEANER CONCENTRATE						
	PRODUCT						
	ORE						
	TAILINGS						
	CLEANER CONCENTRATE						
	PRODUCT						

LABORATORY REPORT

Date Produced 1/29/74

Product or Grade "66 U"

Sample No. or Description Ultrawet D.S. floated product

<u>TEST</u>	<u>FINDINGS</u>	<u>SPECIFIED</u>
MOISTURE	<u>.02</u>	N.M.T. 0.15%
TOTAL ACID SOLUBLE	<u>1.72</u>	N.M.T. 2.0%
MAGNESITE (MgCO.)	<u>.94</u>	N.M.T. 1.10%
COLOR	<u>86.0</u>	WHITE (BY STANDARD)
BULK DENSITY	<u>24.46</u>	20.5 to 25.5 lbs./ft. ³
<u>COMPACTION</u>		
MAX. VOLUME	<u>146 cc</u>	
MIN. VOLUME	<u>82 cc</u>	
AVERAGE VOLUME	<u>114 cc</u>	
SCREENS - 60	<u>100.00</u>	100%
- 100	<u>100.00</u>	N.L.T. 99.7%
- 200	<u>98.66</u>	N.L.T. 98.5%
- 325	<u>85.55</u>	
<u>TRACE ELEMENTS</u>		
ARSENIC	<u>.13</u>	N.M.T. 2ppm.
HEAVY METALS	<u>less than 10</u>	N.M.T. 10 ppm.
WATER SOLUBLE IRON	<u>pass test</u>	PASS TEST
MICROSCOPIC EXAMINATION	<u>pass test</u>	PASS TEST
pH	<u>8.89</u>	

LABORATORY REPORT

Date Produced 1/29/74

Product or Grade "66 A"

Sample No. or Description N-butanol floated product

<u>TEST</u>	<u>FINDINGS</u>	<u>SPECIFIED</u>
MOISTURE	<u>.03</u>	N.M.T. 0.15%
TOTAL ACID SOLUBLE	<u>1.32</u>	N.M.T. 2.0%
MAGNESITE (MgCO.)	<u>.72</u>	N.M.T. 1.10%
COLOR	<u>87.0</u>	WHITE (BY STANDARD)
BULK DENSITY	<u>22.40</u>	20.5 to 25.5 lbs./ft. ³
<u>COMPACTION</u>		
MAX. VOLUME	<u>130 cc</u>	
MIN. VOLUME	<u>94 cc</u>	
AVERAGE VOLUME	<u>112 cc</u>	
SCREENS - 60	<u>100.00</u>	100%
- 100	<u>100.00</u>	N.L.T. 99.7%
- 200	<u>98.99</u>	N.L.T. 98.5%
- 325	<u>91.27</u>	
<u>TRACE ELEMENTS</u>		
ARSENIC	<u>.07</u>	N.M.T. 2ppm.
HEAVY METALS	<u>less than 10</u>	N.M.T. 10 ppm.
WATER SOLUBLE IRON	<u>pass test</u>	PASS TEST
MICROSCOPIC EXAMINATION	<u>pass test</u>	PASS TEST
pH	<u>8.47</u>	

Table 5

LABORATORY REPORT

Date Produced 1/29/74

Product or Grade "66 AC"

Sample No. or Description N-butanol, citric acid floated
product

<u>TEST</u>	<u>FINDINGS</u>	<u>SPECIFIED</u>
MOISTURE	<u>.02</u>	N.M.T. 0.15%
TOTAL ACID SOLUBLE	<u>1.23</u>	N.M.T. 2.0%
MAGNESITE (MgCO.)	<u>.66</u>	N.M.T. 1.10%
COLOR	<u>87.4</u>	WHITE (BY STANDARD)
BULK DENSITY	<u>21.64</u>	20.5 to 25.5 lbs./ft. ³
<u>COMPACTION</u>		
MAX. VOLUME	<u>140 cc</u>	
MIN. VOLUME	<u>100 cc</u>	
AVERAGE VOLUME	<u>120 cc</u>	
SCREENS - 60	<u>100.00</u>	100%
- 100	<u>100.00</u>	N.L.T. 99.7%
- 200	<u>.99.15</u>	N.L.T. 98.5%
- 325	<u>91.97</u>	
<u>TRACE ELEMENTS</u>		
ARSENIC	<u>.17</u>	N.M.T. 2ppm.
HEAVY METALS	<u>less than 10</u>	N.M.T. 10 ppm.
WATER SOLUBLE IRON	<u>pass test</u>	PASS TEST
MICROSCOPIC EXAMINATION	<u>pass test</u>	PASS TEST
pH	<u>7.64</u>	

Table 6

COMPARITIVE TALC RECOVERIES DURING REAGENT TRIAL PERIOD

	Ultrawet D.S.	n-butanol	n-butanol citric acid
H	67.05	63.54	61.49
T	40.15	26.70	23.95
C	98.08	98.80	98.71
% RECOVERY	67.93	79.45	80.61
% CHANGE VS. ULTRAWET COLLECTION PERIOD	0	+16.97	+18.67

H=% acid insoluble content of ore
T=% acid insoluble content of tailings
C=% acid insoluble content of cleaner concentrate

OVERSIZE COUNT

Number percent particle size distribution of

"66 U"-Ultrawet D.S. Floated Talc 1/29/74

SIZE (microns)	NUMBER	% GREATER THAN STATED SIZE
1.0	4113	100.00
2.5	3712	90.25
5.0	2431	59.11
10	1106	26.89
15	556	13.52
20	297	7.22
30	79	1.92
40	36	.88
50	12	.29
60	2	.05

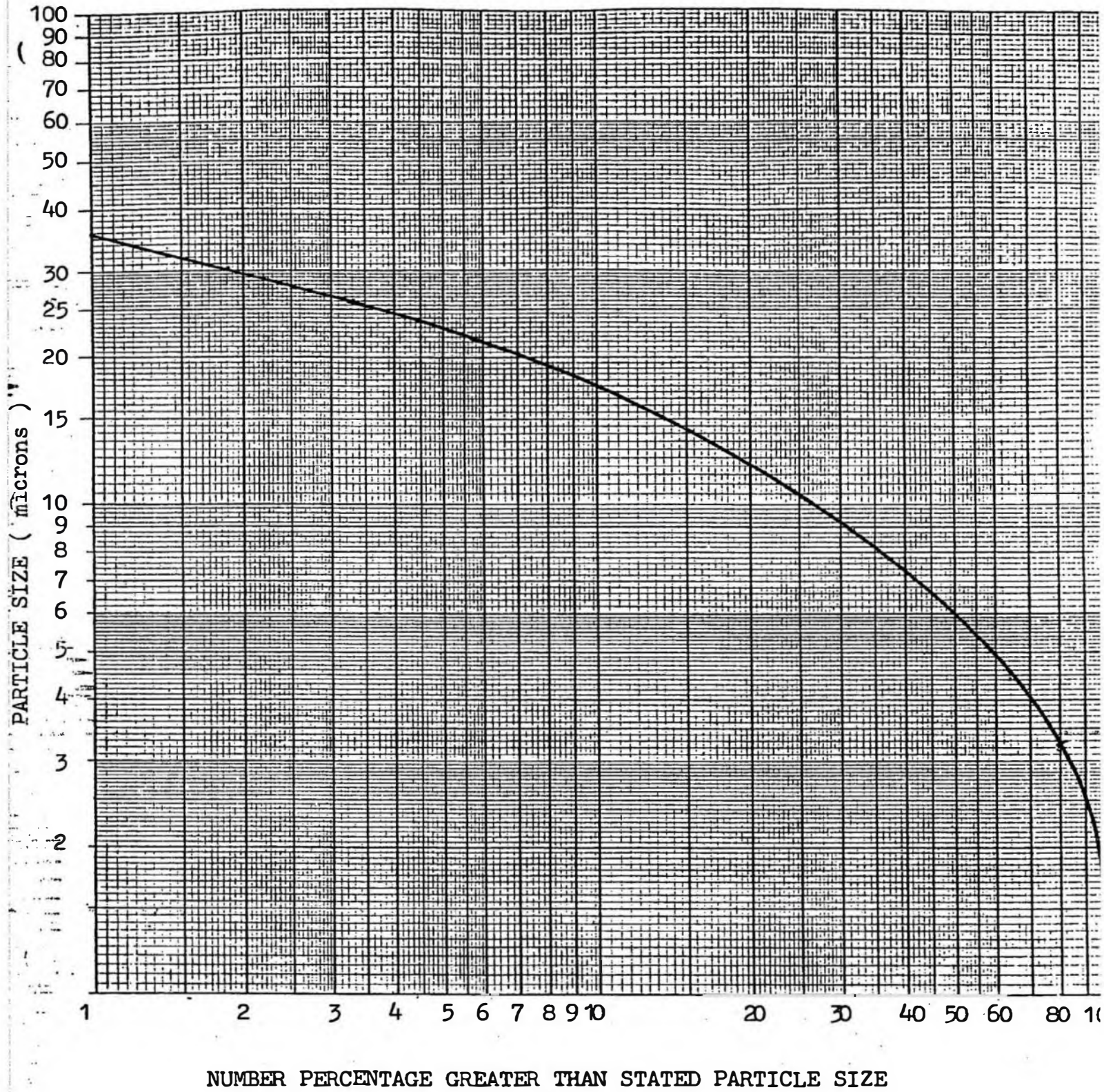
} 9.75

MEAN SIZE = 8.62 microns

Note:

Limiting Detection Threshold = 2.0 microns

NUMBER PERCENT PARTICLE SIZE DISTRIBUTION BY OVERSIZE COUNT OF
"66 U"- Ultrawet D.S. Floated Talc 1/29/74



NUMBER PERCENTAGE GREATER THAN STATED PARTICLE SIZE

OVERSIZE COUNT

Number percent particle size distribution of

"66 A"- Butanol Floated Talc 1/29/74

SIZE (microns)	NUMBER	% GREATER THAN STATED SIZE
1.0	4399	100.00
2.5	4139	94.08
5.0	2836	64.46
10	1323	30.07
15	757	17.20
20	401	9.11
30	126	2.86
40	41	.93
50	14	.31
60	3	.06

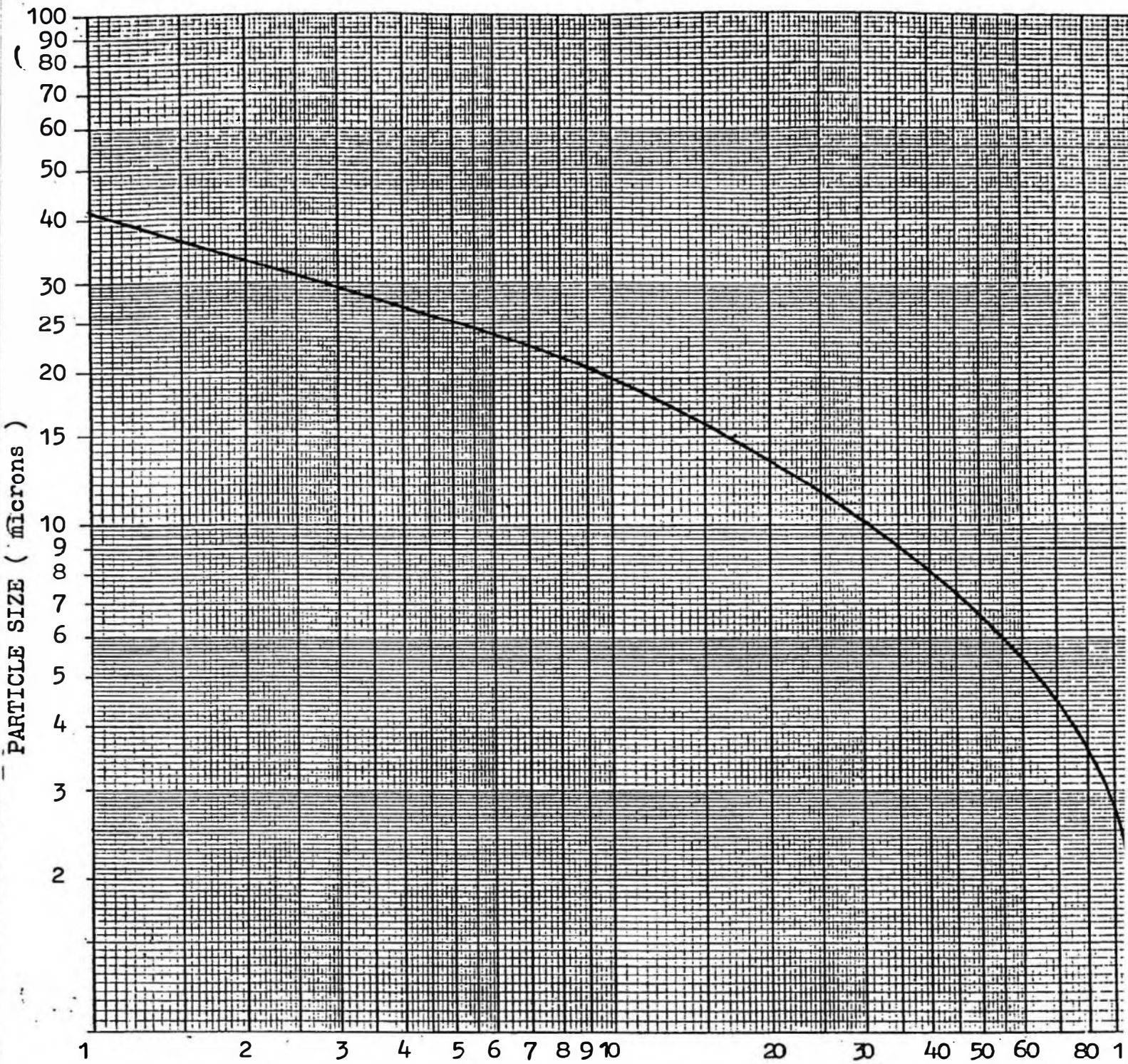
} .5.9%

MEAN SIZE = 9.39 microns

Note:

Limiting Detection Threshold = 2.0 microns

NUMBER PERCENT PARTICLE SIZE DISTRIBUTION BY OVERSIZE COUNT OF
"66 A"- N-butanol Floated talc 1/29/74



NUMBER PERCENTAGE GREATER THAN STATED PARTICLE SIZE

OVERSIZE COUNT

Number percent particle size distribution of

"66 AC"- Butanol, Citric Acid Floated Talc 1/29/74

SIZE (microns)	NUMBER	% GREATER THAN STATED SIZE
1.0	4035	100.00
2.5	4003	99.20
5.0	3105	76.95
10	1632	40.44
15	863	21.38
20	513	12.71
30	160	3.96
40	53	1.31
50	12	.29
60	8	.19

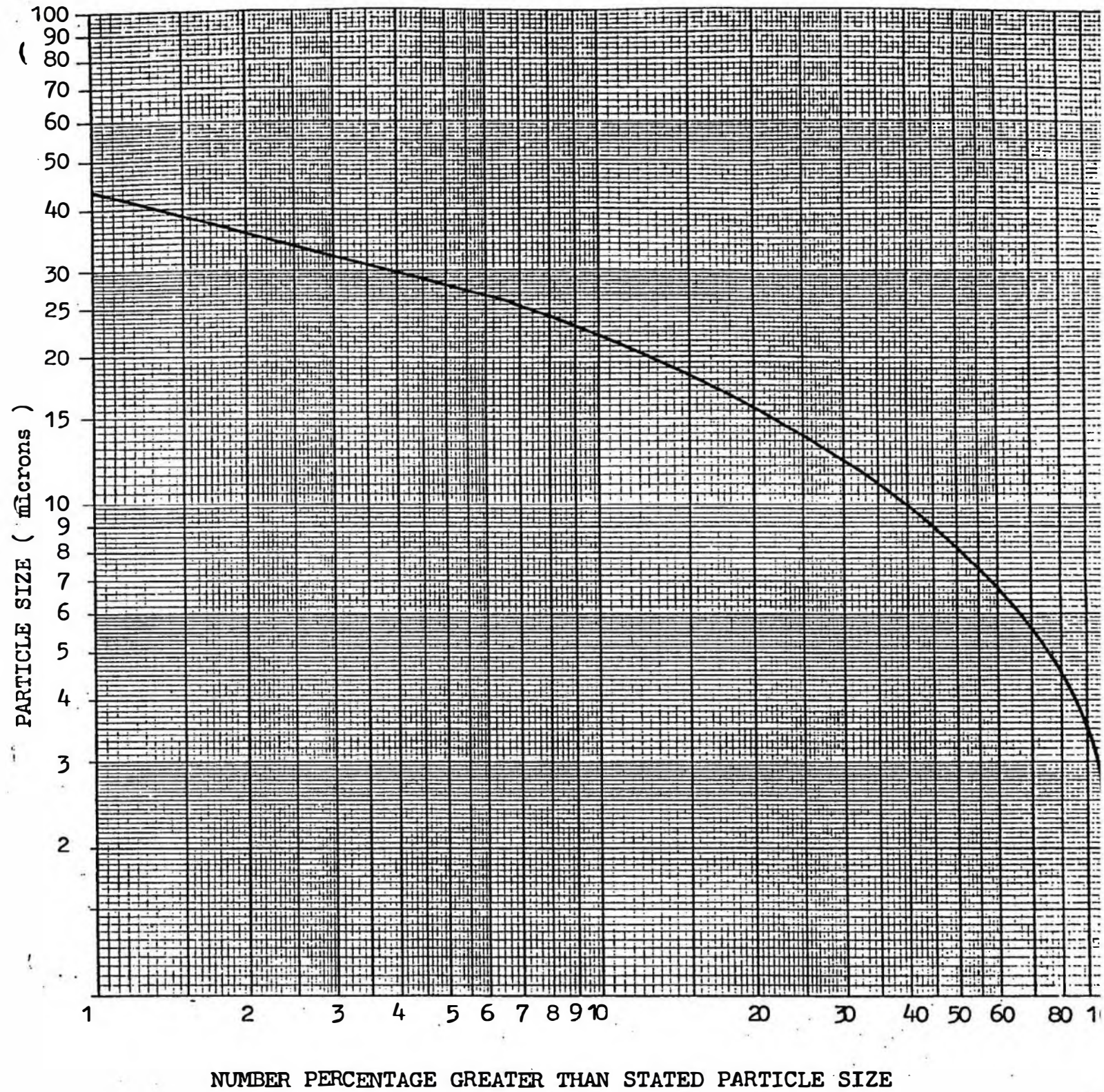
} 0.4

MEAN SIZE = 11.08 microns

Note:

Limiting Detection Threshold = 2.0 microns

**NUMBER PERCENT PARTICLE SIZE DISTRIBUTION BY OVERSIZE COUNT OF
"66 AC"- N-butanol, Citric Acid Floated talc 1/29/74**



NUMBER PERCENTAGE GREATER THAN STATED PARTICLE SIZE

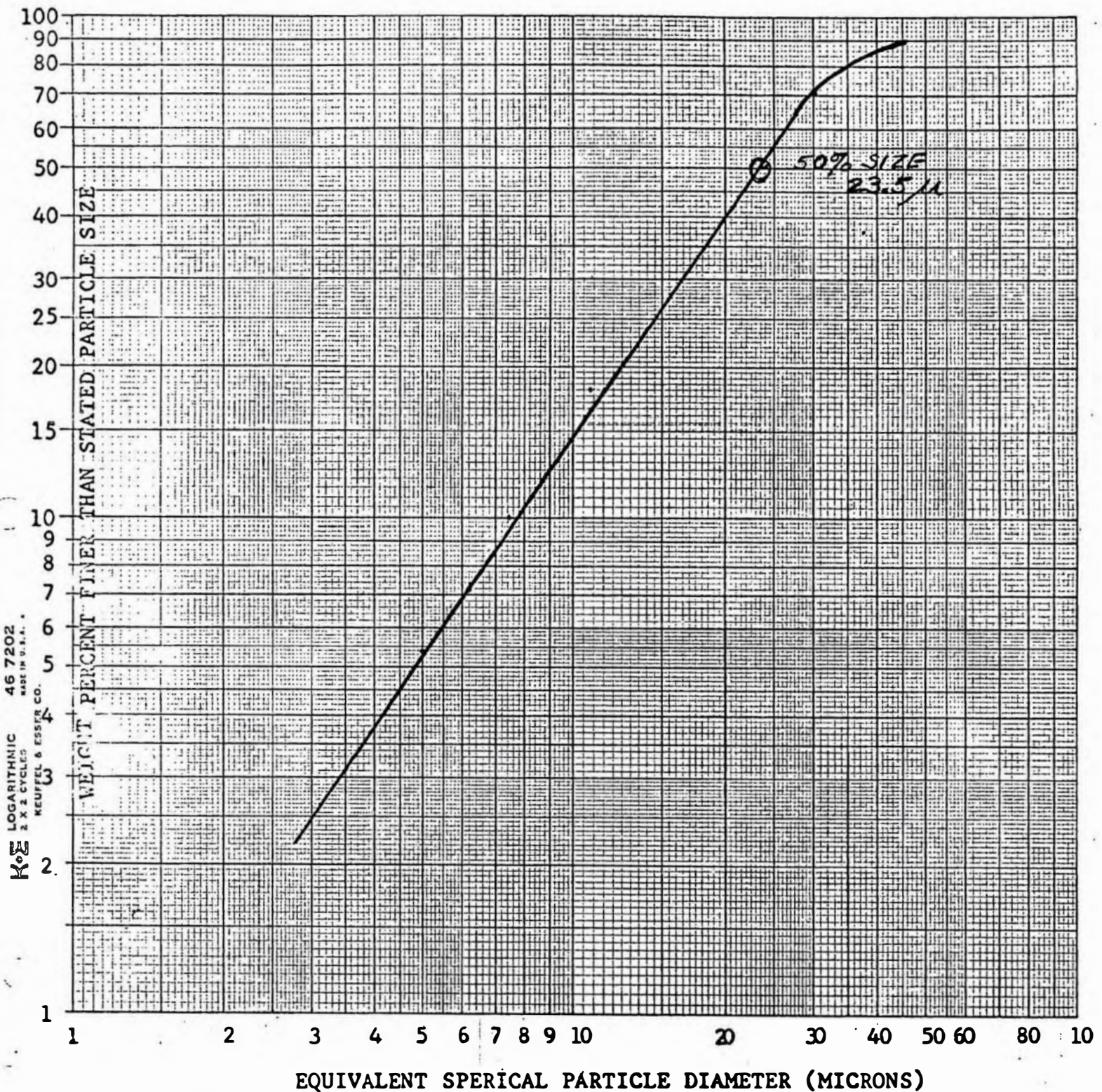
Weight percent particle size distribution
by Andreasen Sedimentation Pipette
of Ultrawet Floated Grade "66 U" Production Talc 1/29/74

Time (min.)	Height (cm)	Wt. (mg)	Equivalent spherical diameter (microns)	Percent less than stated size
2	20.50	89.3	43.0	87.3
4	20.08	72.1	30.1	70.1
6	19.66	52.1	24.3	50.1
30	19.24	20.0	10.8	18.0
60	18.82	12.0	7.5	10.0
90	18.40	9.2	6.1	7.2
130	17.98	7.4	5.0	5.4

Particle Size in Microns
(Equivalent Spherical Diameter) Percent by weight

Less Than	Greater Than	
	43.0	12.7
43.0	30.1	17.2
30.1	24.3	20.0
24.3	10.8	32.1
10.8	7.5	8.0
7.5	6.1	2.8
6.1	5.0	1.8
5.0		5.4

PARTICLE SIZE DISTRIBUTION
BY ANDREASEN PIPETTE OF ULRAWET FLOATED GRADE "66 U"
PRODUCTION TALC 1/29/74



Particle Size Distribution

By Andreasen Pipette of Ultrawet Floated Grade "66 U"

Production Talc 1/29/74

Weight Percent Finer Than
Stated Particle Size

100
90
80
70
60
50
40
30
20
10

Equivalent Spherical Particle Diameter (Microns)

50 40 30 20 10 9 8 7 6 5 4 3 2

EUGENE DIEZGEN CO.
MADE IN U.S.A.

NO. 340-L210 DIEZGEN GRAPH PAPER
SEMI-LOGARITHMIC
2 CYCLES X 10 DIVISIONS PER INCH

Weight percent particle size distribution
by Andreasen Sedimentation Pipette
of Butanol Floated Grade "66A" Production Talc 1/29/74

Time (min.)	Height (cm)	Wt. (mg)	Equivalent spherical diameter(microns)	Percent less than stated size
2	20.50	88.6	43.0	86.6
4	20.08	73.9	30.1	71.9
6	19.66	61.8	24.3	59.8
30	19.24	23.6	10.8	21.6
60	18.82	14.7	7.5	12.7
90	18.40	11.7	6.1	9.7
130	17.98	9.1	5.0	7.1

Particle Size in Microns Percent by weight
(Equivalent Spherical Diameter)

Less Than	Greater Than	
	43.0	13.4
43.0	30.1	14.7
30.1	24.3	12.1
24.3	10.8	38.2
10.8	7.5	8.9
7.5	6.1	3.0
6.1	5.0	2.6
5.0		7.1

PARTICLE SIZE DISTRIBUTION
BY ANDREASEN PIPETTE OF BUTANOL FLOATED GRADE "66A"
PRODUCTION TALC 1/29/74

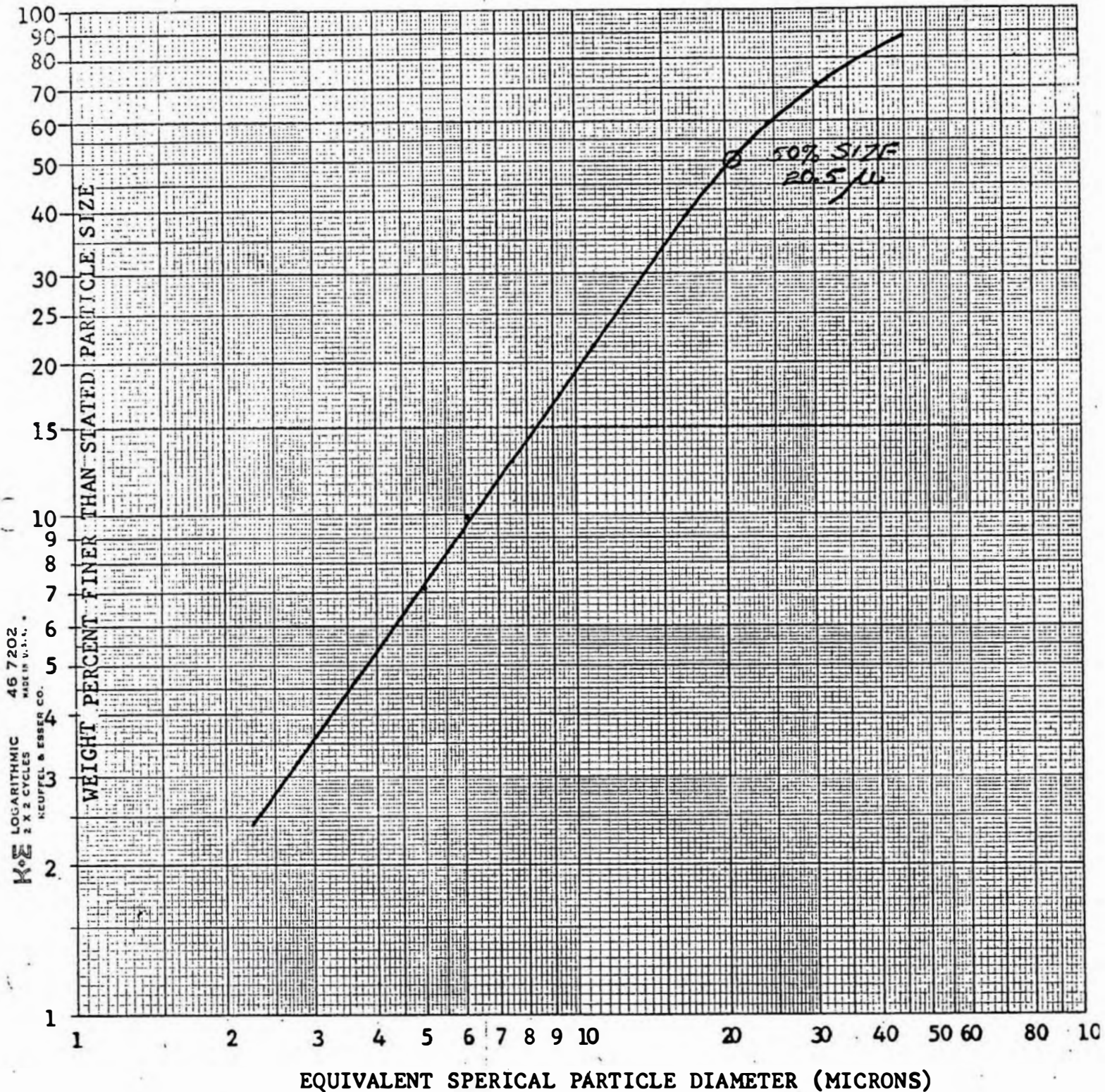
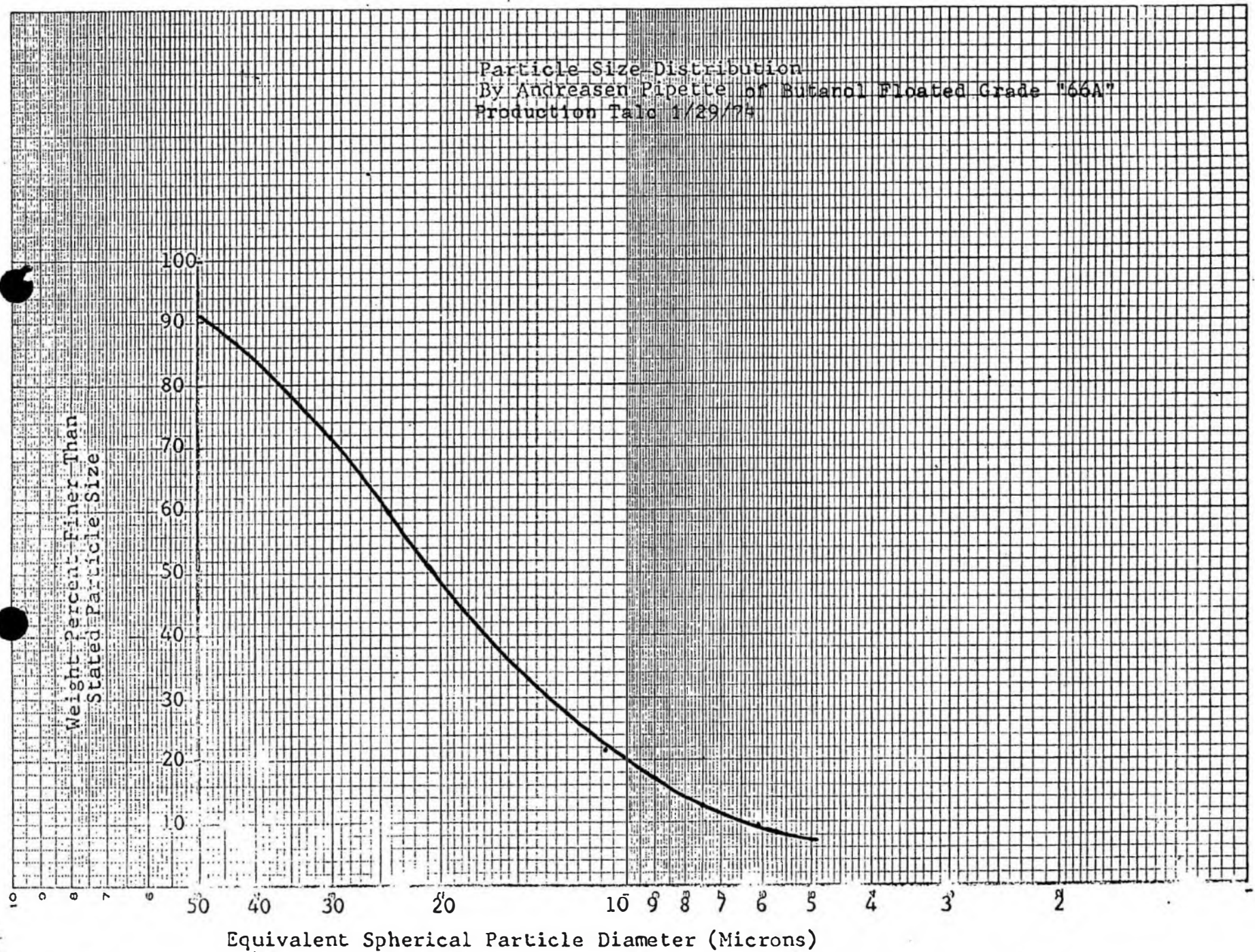


Figure 7



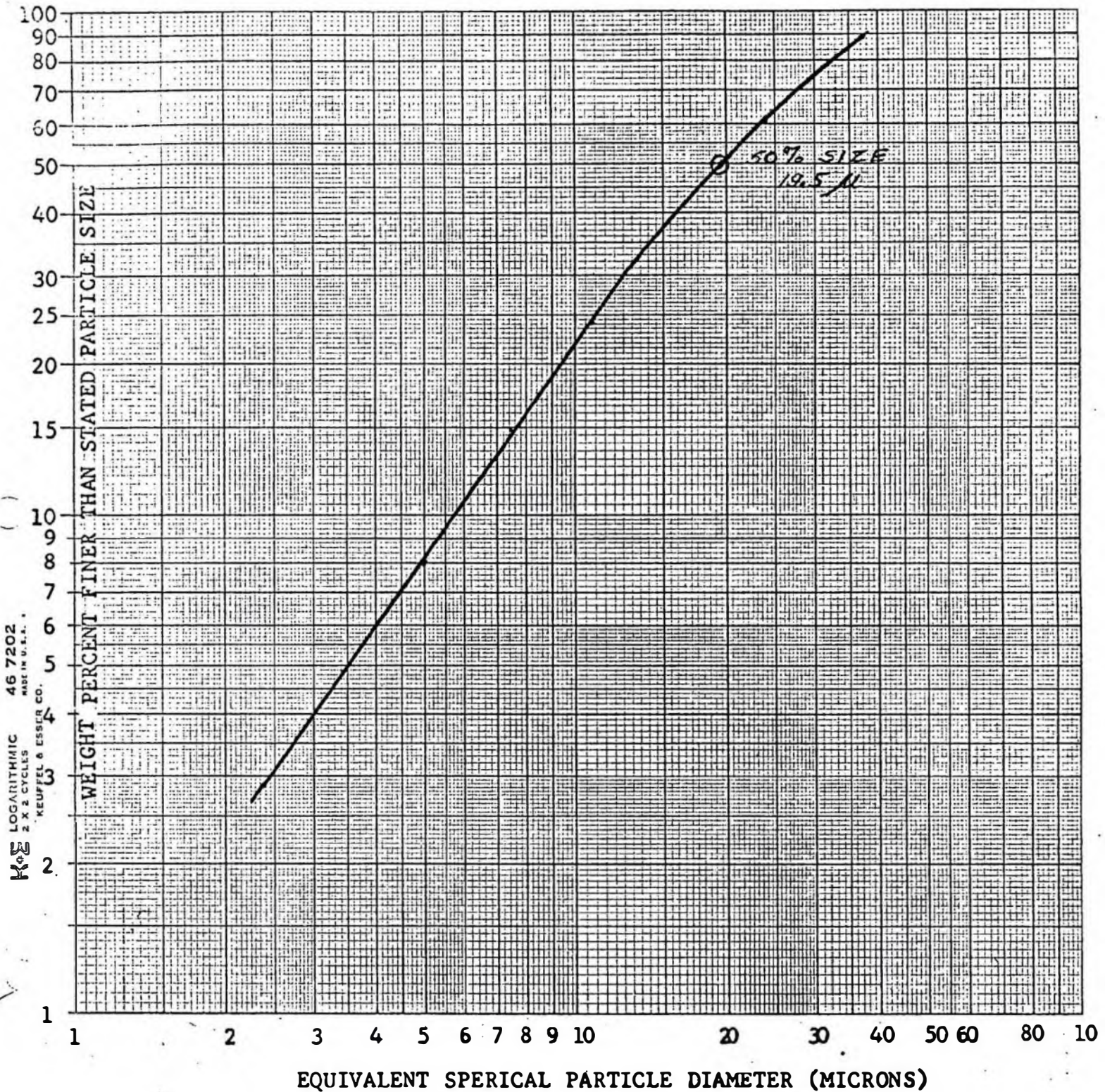
Weight percent particle size distribution
 by Andreasen Sedimentation Pipette
 of Butanol-Citric Floated Grade "66AC" Production Talc 1/29/74

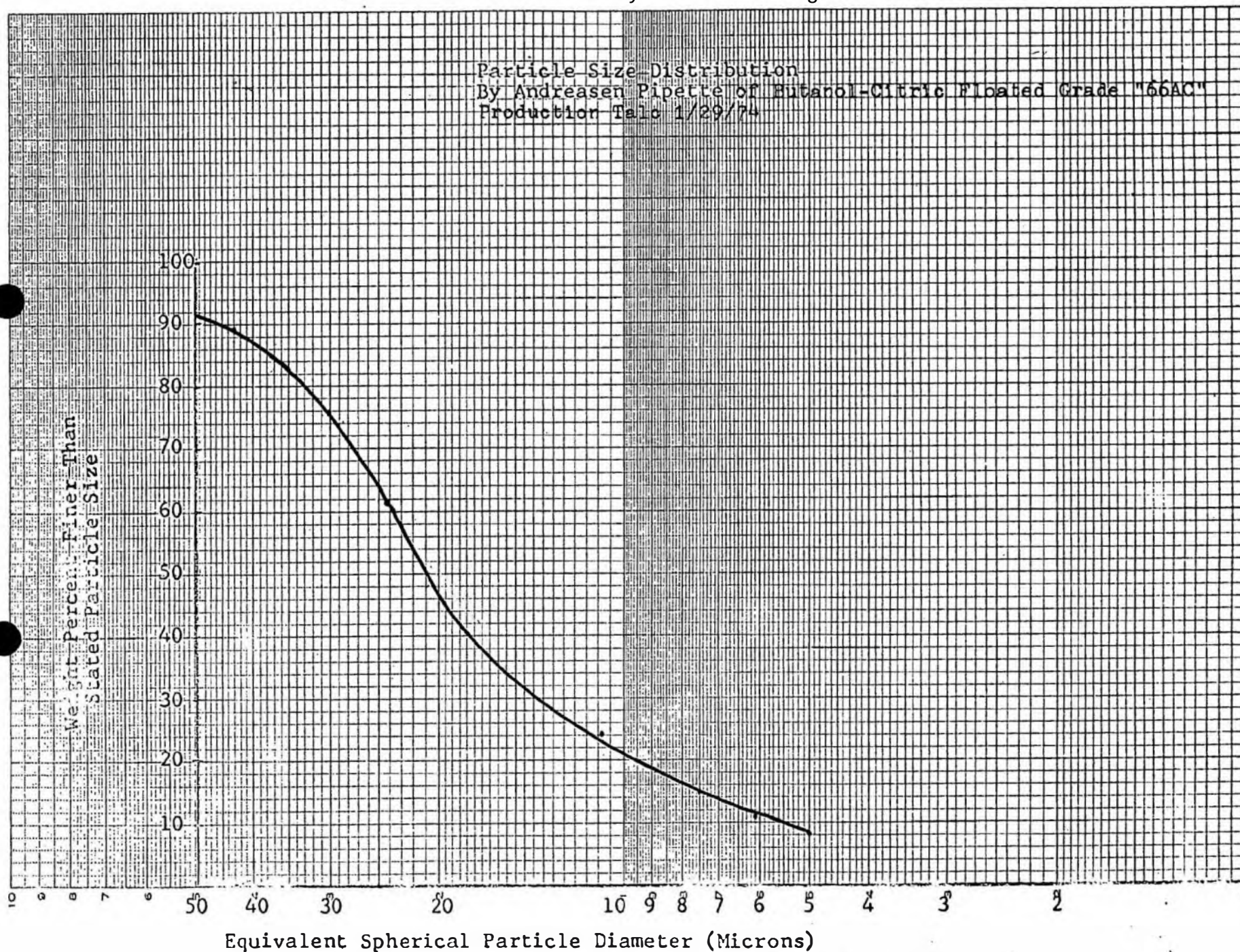
Time (min.)	Height (cm)	Wt. (mg)	Equivalent spherical diameter(microns)	Percent less than stated size
2	20.50	90.7	43.0	88.7
4	20.08	77.9	30.1	75.9
6	19.66	63.2	24.3	61.2
30	19.24	26.1	10.8	24.1
60	18.82	16.9	7.5	14.9
90	18.40	12.9	6.1	10.9
130	17.98	10.1	5.0	8.1

Particle Size in Microns
 (Equivalent Spherical Diameter) Percent by weight

Less Than	Greater Than	
	43.0	11.3
43.0	30.1	12.8
30.1	24.3	14.7
24.3	10.8	37.1
10.8	7.5	9.2
7.5	6.1	4.0
6.1	5.0	2.8
5.0		8.1

**PARTICLE SIZE DISTRIBUTION
BY ANDREASEN PIPETTE OF BUTANOL-CITRIC FLOATED GRADE "66AC"
PRODUCTION TALC 1/29/74**





EUGENE DIEZGEN CO.
MADE IN U.S.A.

NO. 340-1210 DIEZGEN GRAPH PAPER
SEMI-LOGARITHMIC
2 CYCLES X 10 DIVISIONS PER INCH

AMPHIBOLE CONTENT OF REAGENT TRIAL PROCESS SAMPLES

Sample designation	Amphibole level (ppm)
A ore	3000
A product	100-200
B ore	3000
B product	100-200
C ore	3000
C product	100-200

LEGEND:

A- Ultrawet D.S. trial period
B- N-butanol trial period
C- N-butanol-citric acid trial period

Relative amounts of chlorite, dolomite, and magnesite
with respect to talc

	Chlorite/Talc	Dolomite/Talc	Magnesite/Talc
ORE A	7.0×10^{-2}	0.12	0.27
ORE B	8.6×10^{-2}	0.11	0.23
ORE C	7.4×10^{-2}	0.11	0.25
PRODUCT A	10×10^{-3}	very small	very small
PRODUCT B	8.6×10^{-3}	very small	very small
PRODUCT C	8.5×10^{-3}	very small	very small
TAILS A	0.28	0.78	1.2
TAILS B	2.6	5.7	11
TAILS C	2.4	6.0	12

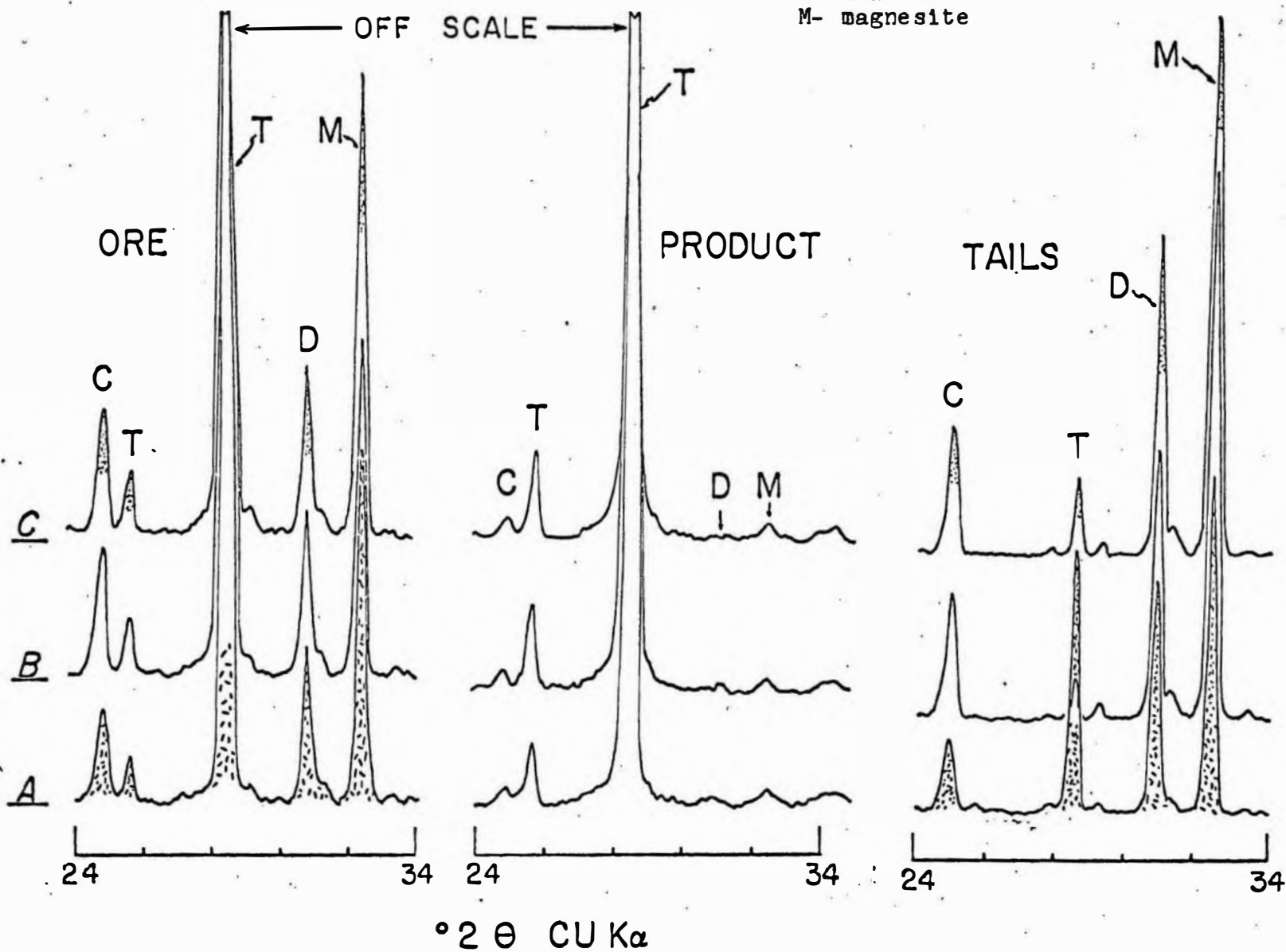
LEGEND:

- A- Ultrawet D.S. trial period
- B- N-butanol trial period
- C- N-butanol-citric acid trial period

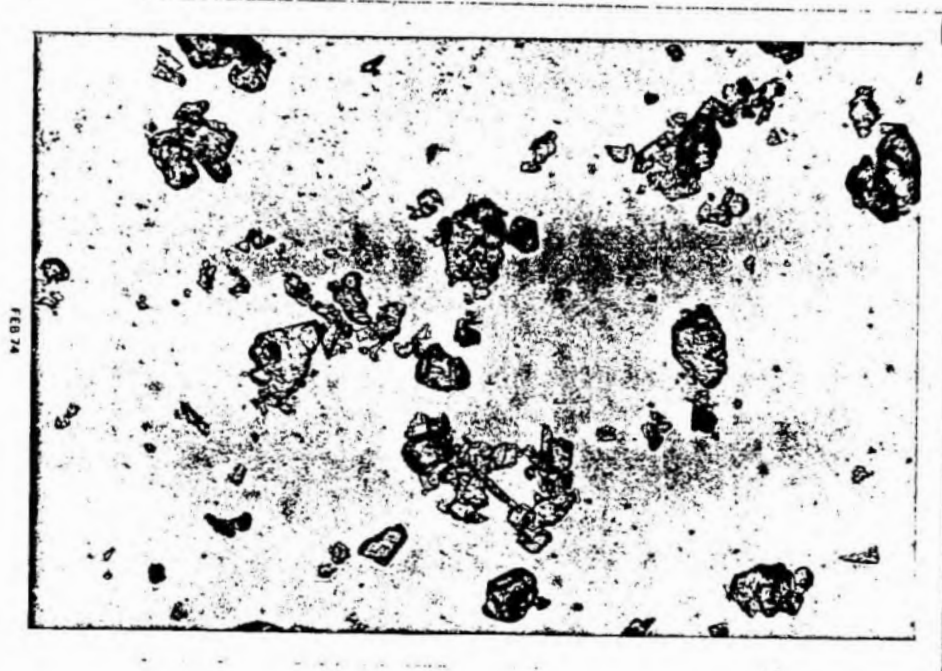
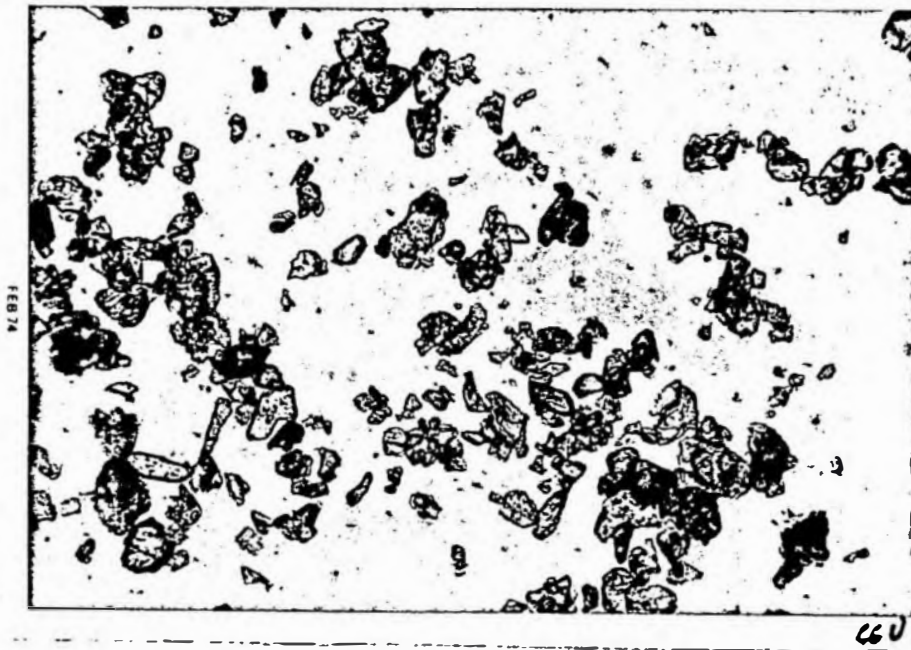
X-RAY DIFFRACTION PATTERNS OF REAGENT TRIAL TALC PROCESS SAMPLES

A- Ultrawet D.S. trial period
 B- n-butanol trial period
 C- n-butanol trial period

C- chlorite
 T- talc
 D- dolomite
 M- magnesite

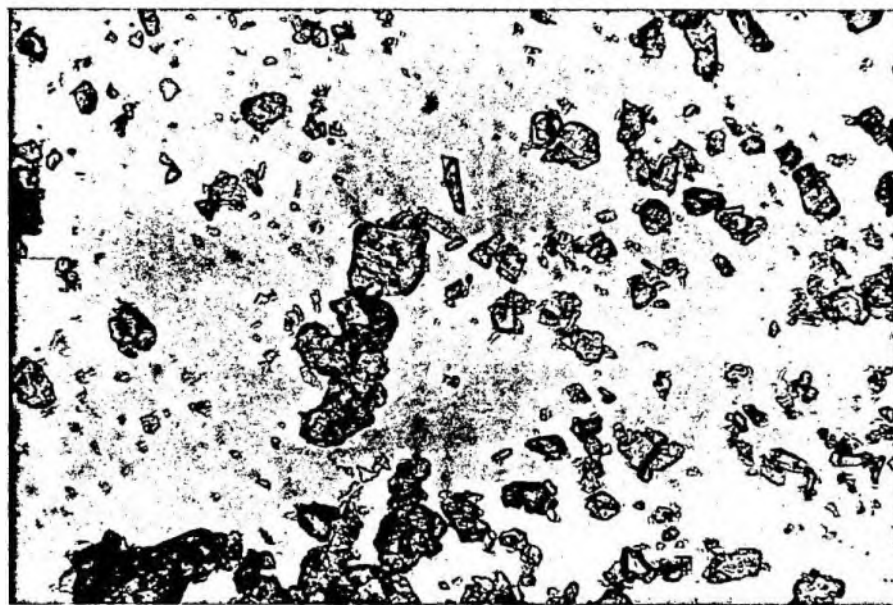
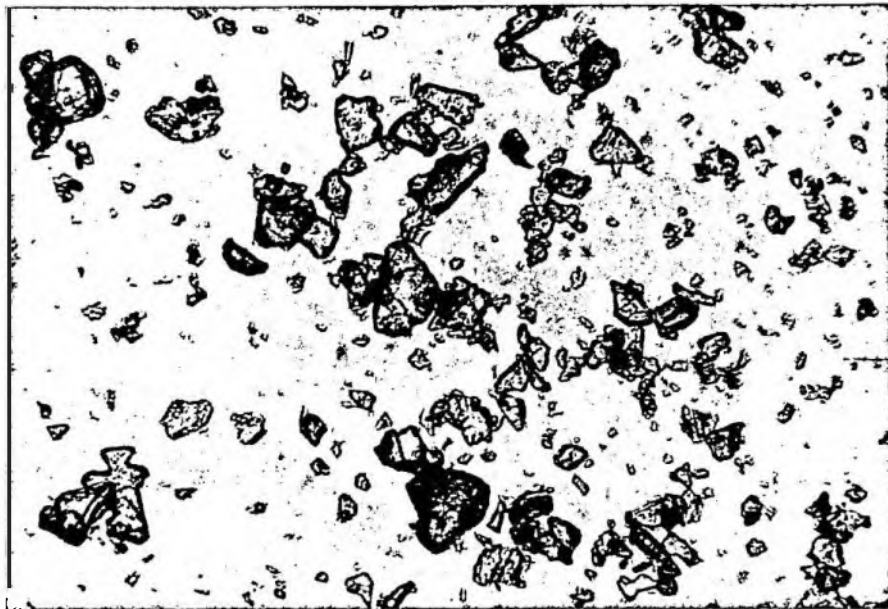


PHOTOMICROGRAPHY OF "66 U"- Ultrawet D.S. Floated Product



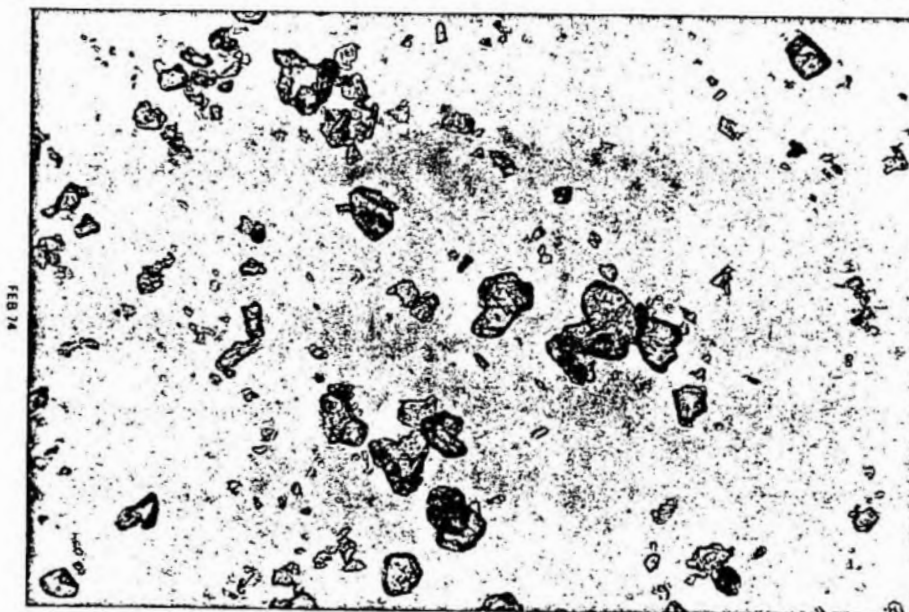
Magnification- 100X

PHOTOMICROGRAPHY OF "66 A"- N-butanol Floated Product



Magnification- 100X

PHOTOMICROGRAPHY OF "66AC"- N-butanol Floated Product



Magnification- 100X

ASBESTIFORM FIBER COUNTS BY WALTER C. MC CRONE ASSOCIATES

Sample designation	Fiber count per E.M. grid	Fiber identification
66-U-Ore	0	
66-U-Product	1	Probably chrysotile
66-A-Ore	1	Probably chrystile
66-A-Product	0	
66-AC-Ore	8	Chrysotile
66-AC-Product	1	Chrysotile

LEGEND:

66-U- Time period using Ultrawet D.S.
66-A- Time period using n-butanol
66-AC- Time period using n-butanol-citric acid

ATTACHMENT B

**ASBESTIFORM DEPRESSION
THROUGH THE USE OF
NEW FLOATATION REAGENT SYSTEMS**

INTRODUCTION:

A study was performed at Windsor Minerals to quantify the effectiveness of two new floatation reagent systems in the depression of asbestiform minerals in the floatation process. Analysis of the floated products was accomplished using a Millipore TMC Image Analyzer as the analytical detection device.

CONCLUSIONS:

1. A combination of n-butyl alcohol as a frother along with citric acid as a depressive agent proved to be 20 times as effective as Ultrawet D.S. suppressing asbestiforms in the final product.
2. Using only n-butyl alcohol as a frother proved to be 7 times as effective as Ultrawet D.S. in suppressing asbestiforms.
3. Ultrawet D.S. provided only a minimal suppression of asbestiforms through the floatation process.

EXPERIMENTAL:

Ground ore from the Hammondsville Mine was "doped" with 1.0% by weight of the fibrous form of anthophyllite which occurs as a rare mineral in the Hammondsville ore body, and subjected to a series of laboratory floatations using the following reagent systems:

1. Ultrawet D.S.
2. n-butyl alcohol
3. n-butyl alcohol-citric acid.

The products obtained from these laboratory floatations were scanned on a video monitor coupled to an optical microscope, the system having a useful magnification of 500X. Clearly recognizable asbestiform anthophyllite was counted and totalized over 100 viewed fields. The number of particles viewed in the 100 fields were totalized by means of a complementary computer interfaced to the system. The numbers obtained by this technique were compared to those obtained by an identical analysis of a standard preparation consisting of a Grade "66" product "doped" with 2.0% by weight of fibrous anthophyllite.

RESULTS:

Table 1 gives the data and calculated numerical relationships devised to indicate the effectiveness of the new reagent systems in the depression of fibrous anthophyllite. These relationships, their value and definitions are as follows:

1. **Rejection factor:** a relationship derived to indicate the weight rejection of anphophylite using a given reagent system. This relationship is arrived at by comparing the anthophylite weight percentage in the floated product to the 2.0% asbestiform "doped" product which represents a floated material having undergone no rejection of asbestiforms from the ore to the product.

The Rejection Factor is defined in these experiments for a given floatation reagent as:

$$\frac{2.0}{\text{anthophylite weight percentage in floated product}}$$

2. **Rejection Ratio** - This term relates the effectiveness of suppression of asbestiforms by the alcohol based systems, to the existing Ultrawet D.S. system and is defined as follows:

$$\text{Rejection Ratio} = \frac{\text{Rejection Factor of new reagent system}}{\text{Rejection Factor of Ultrawet D.S. system}}$$

Table I Asbestiform Analysis of Cosmetic Grade Talcs Using TMC Image Analyzer.

	<u>2.0% Asbestiform Containing Product</u>	<u>Ultrawet D.S. Floated Product</u>	<u>N-Butyl Alcohol Floated Product</u>	<u>N-Butyl Alcohol Citric Acid Floated Product</u>
Total Fields Counted	100	100	100	100
Total Fibers Counted	298	37	6	2
Total Particles Counted	10681	9166	11416	10103
Weight Percentage Asbestiform	2.00	.2894	.0377	.0142
Rejection Factor	1.00	6.91	53.08	140.94
Rejection Ratio	--	1.00	7.68	20.39

SUMMARY AND REMARKS:

The data shows a profound influence of the alcohol based reagent system upon the amounts of asbestiforms reporting in the floated product. It is apparent that the system which includes citric acid is more effective than n-butanol alone.

Although the data was accumulated for the specific mineral species, fibrous anthophyllite, the same results can be predicted for other fibrous amphibole minerals and chrysotile asbestos found in association with the Hammondsville ore body whose surfaces expose a substantial concentration of magnesium and hydroxyl groups as reactive sites.

ATTACHMENT C

**MINEROLOGY OF ORES, PRODUCTS AND MILL TAILS RE
DIFFERENT FLOATATION REAGENTS**

TO: WINDSOR MINERALS INC., Windsor, Vermont 05089

FROM: R. C. Reynolds, Jr., Department of Earth Sciences
Dartmouth College, Hanover, N.H. 03755

SUBJECT: Mineralogy of Ores, Products and Mill Tails Re
Different Flotation Reagents

INTRODUCTION:

A study was made of the mineralogy of talc products and mill tails that were produced by the use of three different flotation schemes. The designations and descriptions used in this report are as follows:

Flotation Agent	Designation
Ultrawet	A
Butanol	B
Butanol + Citric Acid	C

In addition, studies were made of the ore that produced each of the products and mill tails.

TECHNIQUE:

Ores, products, and tails were analyzed by x-ray diffraction methods. Copper $\kappa\alpha$ radiation was used and the region $2\theta = 24$ to $2\theta = 34^\circ$ was scanned. This 2θ region contains important peaks from talc, chlorite, dolomite and magnesite. Examples of runs are shown on Figure 1. The data in Table 1 was obtained by averaging peak heights from three scans of each sample.

Materials were studied for amphiboles by means of the heavy-liquid-benzethonium chloride method described in the Windsor Mineral Report of March, 1974. To improve separation and subsequent semi-quantitative estimation of amphibole, product samples were spiked with dolomite and tourmaline, sized 10-40 μ , to better simulate the ores, which behave well in the amphibole separation procedure.

RESULTS:

Figure 1 shows the x-ray diffraction patterns of ores, products, and tails associated with each of the flotation procedures.

Peaks are labelled C = chlorite, T = Talc, D = dolomite, and M = magnesite. The results clearly show

- (1) the low chlorite, magnesite, and dolomite in all of the products
- (2) the large amounts of magnesite, dolomite, and chlorite in ores and tails
- (3) the low concentration of talc in tails B and C

Ores A, B and C are similar as are products A, B and C. The only significant difference among the three treatments shows in the tails; those from treatment A (ultrawet) clearly have a much large talc content than do the tails from the butanol or the butanol-citric acid experiment.

Table 1 shows data tabulated from repeated (three times) runs similar to those shown on Figure 1. The values are meaningful only in a relative sense. There appear to be no significant differences among ores A, B and C, and products A, B and C.

The major difference is among the tails, where tails A is clearly much richer in talc than tails B or tails C.

It is concluded that:

- (1) The ores used for the three flotation experiments are very similar or identical in mineralogy
- (2) The products A, B and C are similar except that product A does have a slightly higher chlorite content
- (3) The tails for B and C are similar, but tails A is clearly higher in talc. Hence, the ultrawet flotation agent clearly produced a higher loss of talc to the mill tails than did the butanol or butanol-citric acid reagents

The results from the amphibole separation are somewhat ambiguous because of the difficulties in obtaining reproduceable extractions from the products. However, the tourmaline added to products A and B was recovered to within $\pm 10\%$ for each, giving confidence in the efficiency of the separation. Based on optical estimates from these samples, and separations of the three done without tourmaline, it is concluded that all three products contain essentially similar concentrations of actinolite, and that its absolute concentration lies between 100 and 200 ppm.

CONCLUSIONS:

As a result of the mineralogical studies reported here, the following are concluded:

- (1) Ores A, B and C are essentially identical with respect to their concentrations of magnesite, dolomite, chlorite and actinolite

- (2) Tails B and C are identical with respect to talc, magnesite, dolomite and chlorite, but tails A is significantly richer in talc
- (3) Products A, B and C are essentially identical with respect to their concentrations of magnesite, dolomite and actinolite; Product A contains a somewhat larger quantity of chlorite
- (4) Amphibole separations from products are difficult to achieve quantitatively, but the addition of carbonate and silicate carriers seems promising in eliminating the difficulties

TABLE 1

X-RAY DIFFRACTION PEAK RATIOS FROM ORES, PRODUCTS AND TAILS

	Magnesite/Talc	Dolomite/Talc	Chlorite/Talc
Ore A	0.27	0.12	0.070
Ore B	0.23	0.11	0.086
Ore C	0.25	0.11	0.074
Product A	Very low	Very low	0.0100
Product B	Very low	Very low	0.0086
Product C	Very low	Very low	0.0085
Tails A	1.2	0.78	0.28
Tails B	10.9	5.7	2.6
Tails C	12.2	6.0	2.4

TABLE 2

ACID INSOLUBLE HEAVY LIQUID RESIDUES FROM PRODUCTS, ORES AND TAILS

	PPM TOTAL	PPM ESTIMATED AMPHIBOLE
Ore A	9000	~3000
Ore B	10,500	~3000
Ore C	8800	~3000
Product A		100-200*
Product B		100-200*
Product C		100-200*
Tails A	34,600	too much chlorite
Tails B	36,100	too much chlorite
Tails C	44,100	too much chlorite

*See text

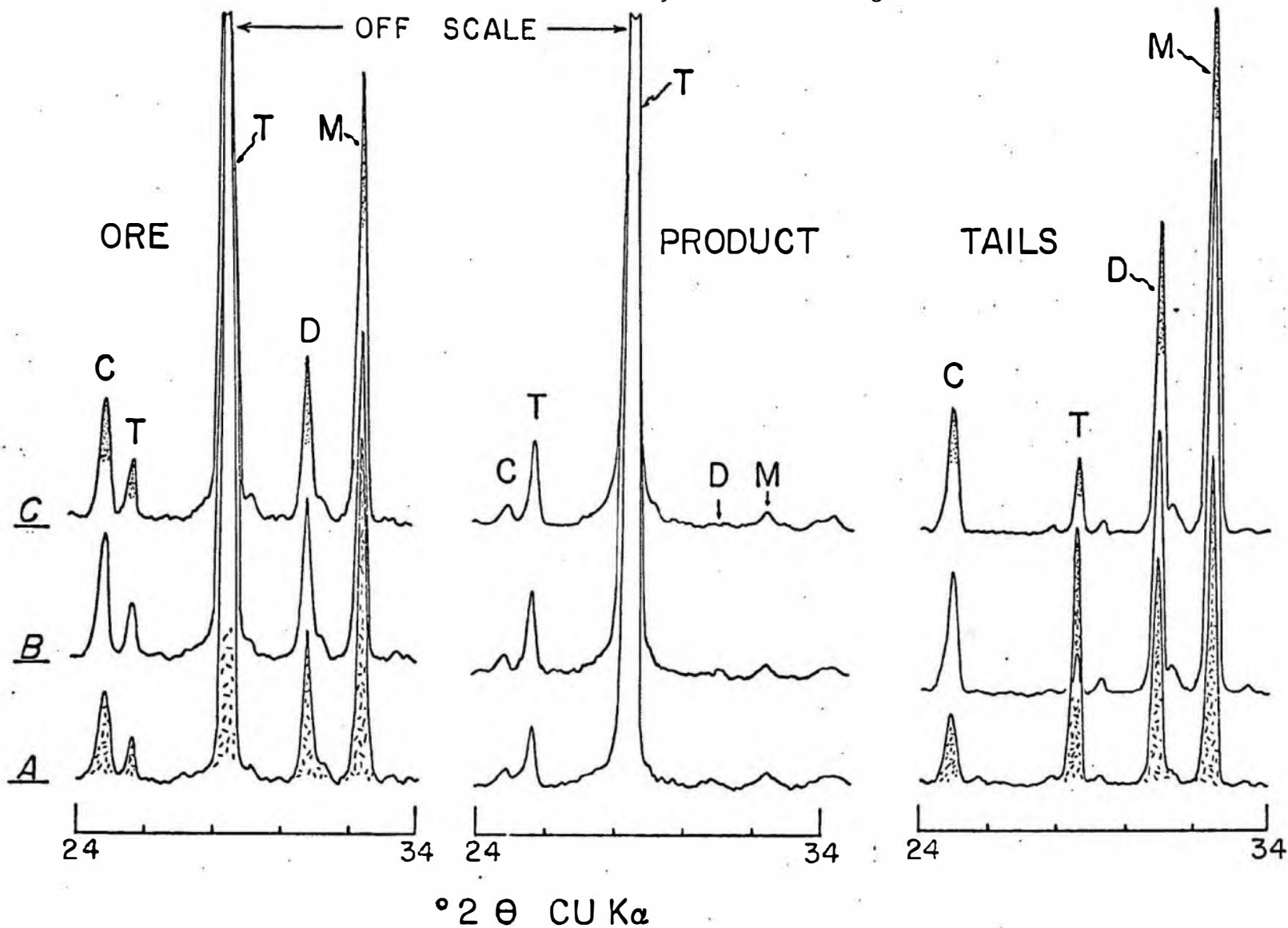


Figure 1 X-ray diffraction traces of ores, products and mill tails. Chlorite = C, talc = T, magnesite = M, and dolomite = D.

Exhibit 10

Amphibole Content of Cosmetic and Pharmaceutical Talcs

by A. M. Blount*

Pharmaceutical and cosmetic-grade talcs were examined for asbestosiform amphibole content using a new density-optical method. Talcs under the Food and Drug Administration are not regulated as to asbestos content; however, all talcs were well below the level mandated by the Occupational Safety and Health Administration for industrial talcs. Only one was found to contain an amphibole particle size distribution typical of asbestos.

Introduction

In 1973 the Food and Drug Administration (FDA) proposed a regulation on the permissible asbestos content of talc (1). This regulation proposed to limit the amount of amphibole minerals to less than 0.1% and chrysotile to less than 0.01%. However, the optical microscopy method proposed was so complicated, lengthy, and subject to error that the proposed method was never finalized. Since then no final ruling has been issued.

The Occupational Safety and Health Administration, on the other hand, has been more rigorous and has instituted regulations despite the lack of methods to carry out the required measurements. One regulation, instituted in 1986, defines amphibole minerals as asbestos if the length to width ratio is 3:1 or greater. Because many nonfibrous cleavage fragments of amphibole minerals have a 3:1 aspect or greater and because there is no good evidence for adverse effects of these particles, a stay has been in effect on this part of the regulation (2). The second applicable regulation is the Hazard Communication Regulation (3), which applies to all chemicals used in the workplace. Specifically, it requires labeling of substances containing > 1% of a chemical hazardous to health and > 0.1% of a carcinogenic chemical.

Unfortunately, asbestos and amphiboles cannot be measured using currently developed methods to the level of 0.1% in the presence of talc. Some investigators have suggested that tremolite can be measured to that level by X-ray diffraction. But others have shown that the peak intensities vary between nonfibrous and fibrous tremolite (4) so that the 0.1% level of detection and measurement is doubtful except in cases where the sample has been spiked so that the exact nature of the tremolite is known. For anthophyllite there is little argument about the fact that detection cannot be made to 0.1%. However, the main problem with using X-ray diffraction for detection of amphibole minerals is that it gives no information about the shape of the particles, and shape is important in view of the uncertainty in the outcome of the asbestos regulation pertaining to nonfibrous amphiboles.

The talcs that are pharmaceutical grade fall under the domain of the FDA and are therefore nonregulated in regard to fibrous mineral content. In the course of developing a technique to facilitate quantification of amphiboles in talc (5), pharmaceutical and high-grade talcs were examined. They were found to have very low amphibole content and, because of this, were extensively used in examining the lower limit of detection of the new method. The purpose of this paper is to describe the results of analyses for content and shape of amphibole mineral fragments in cosmetic and pharmaceutical talc powders of the United States.

Methods

The method proposed by the FDA in 1973 for analysis of talc was an optical procedure as described below (1):

Weigh out 1 milligram of a representative portion of talc on each of two microscope slides. Mix the talc with a needle on one slide with a drop of 1.574 refractive index liquid, and then the other with 1.590 liquid, and place on each a square or rectangular cover glass sufficiently large so that the liquid will not run out from the edge (ca. 18 mm square) and will provide a uniform particle distribution. Fibers counted by this method should meet the following criteria: (i) Length to width ratio of 3 or greater (ii) length of 5 μ m or greater (iii) width of 5 μ m or less. Count and record the number of asbestos fibers in each 1 milligram as determined from a scan of both slides with a polarizing microscope at a magnification of approximately 400 \times . In the 1.574 refractive index liquid, chrysotile fibers with indices less than 1.574 in both extinction positions may be present; in the 1.590 refractive index liquid, the other five amphibole types of asbestos fibers with indices exceeding 1.590 in both extinction positions may be present. Check the extinction and sign of elongation for tentative identification. For specific identification of asbestos fibers, make additional mounts in appropriate refractive index liquids, and refer to the optical crystallographic data in the table. A count of not more than 1000 amphibole types of asbestos and not more than 100 chrysotile asbestos fibers per milligram-slide constitutes the maximum limit for the presence of these asbestos fibers in talc. These limits assure a purity of at least 99.9 percent free of amphibole types of asbestos fibers and at least 99.99 percent free of chrysotile asbestos fibers.

The problem with the proposed method is that talc flakes are often oriented vertically or at a sufficient angle that they appear to be needles and thus must be tested for refractive index (Fig. 1). A typical number of such particles is five per field of view. This

*Geology Department, Rutgers University, Newark, N.J. 07102.

FIGURE 1. Talc flakes in 1.584 refractive index liquid. Note that there are particles in this field that have aspect ratios greater than 3:1. Width of view 0.13 mm.

means that some 20,000 particles would need to be examined in a typical case. In addition, chlorite is often present and when on edge must be examined in two extinction positions. This is clearly beyond what could be expected of any sane microscopist for a routine analysis. Since no other procedure has been developed as an alternative, a compromise has been to count 100 fields of view (FOV). In this way one need only examine about 500 particles in detail.

Because 500 particles is still a lengthy process, a more rapid and equally accurate method has been developed based on concentrating the amphibole particles by density difference. Figure 2 illustrates that there is a distinct break in density ranges between talcs and amphiboles. A heavy liquid of intermediate density is used, either Klein's (cadmium borotungstate) or Clerici's (thallium formate-malonate) solution. Experimentation showed that a heavy liquid of density 2.810 gives good separation even though values given in the literature and shown in Figure 2 would suggest that the density should be slightly higher. Because the density difference between particles and liquid is small, to get separation in a reasonable length of time a microcentrifuge is used with tubes containing 1.5 mL liquid. The height of the liquid column is, in this case, about 10 mm.

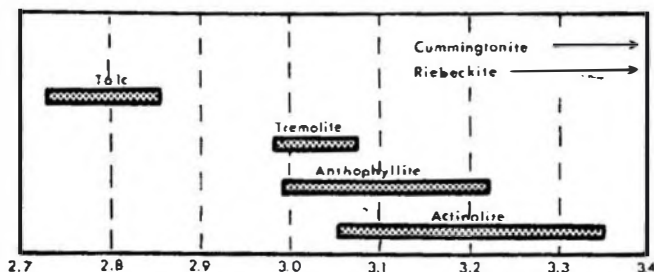


FIGURE 2. Specific gravities of talc and amphibole (6).

The general procedure involves weighing about 60 mg sample into a microcentrifuge tube and adding heavy liquid of density 2.810. After these are mixed, the tube with sample is placed in a vacuum for 3 min to remove the small bubbles adhering to the particles. After centrifuging the sample for 10 min at 7000 rpm, the heavy particles are removed from the bottom of the tube with a micropipette.

The counting of particles can be done either on a membrane filter (Nuclepore, 1.0 μ m pore size) which has been placed on a microscope slide or as particles directly on the glass slide. In the first case, the heavy liquid with sample is forced through a membrane filter followed by distilled water to clean out the heavy liquid. The filter is then placed on a glass slide while wet. When dry, 1.584 refractive index liquid is placed on the filter followed by a cover glass. The photographs shown in this paper are of particles on filters.

The second case, particles directly on the microscope slide, requires transferring the heavy particles and some of the heavy liquid to a second centrifuge tube. Distilled water is added and the sample centrifuged. The liquid is pipetted off and more distilled water added. This is repeated several times to clean out the heavy liquid. Finally, the particles with several drops of water are transferred to a glass microscope slide. The advantage of this procedure is that any refractive index liquid can be used, whereas, in the former case, the refractive index is constrained by having to match the index of the membrane filter (either 1.584 or 1.625). The 1.584 value is good for analyzing amphiboles in talc, but the centrifuge method described has application to other mineral combinations, such as talc-quartz. With other combinations, refractive indices other than the two exhibited by the membrane filter may be more appropriate.

The particles are counted in 20 FOV. Being concentrated from 60 mg or more of sample, one will see more amphiboles than in 100 FOV using the old method. The number of amphibole particles per milligram (ppmg) is calculated:

$$\text{ppmg} = \text{amphibole particles/mg} =$$

$$\frac{(\text{number of amphibole counted/number FOV counted}) \times \text{total number FOV}}{(\text{efficiency}) \times (\text{number of mg of sample})}$$

Efficiency of the spin-down is determined experimentally. For more details of the method see Blount (5).

Figure 3 illustrates the results obtained when testing the method using known mixtures. Because it is difficult to measure and mix in very small weights of amphibole, a sample containing 2% tremolite in talc was mixed with pure talc to make mixtures containing very low percentage values of tremolite. For example, sample A (Fig. 3) consisting of 0.06% tremolite was made by weighing 58.9 mg of pure talc with 1.7 mg of talc containing 2% tremolite ($1.7 \text{ mg}/60.6 \text{ mg} \times 2\% = 0.06\%$). It is not necessary to make a homogeneous mixture since the entire sample was used in the experiment. Also, the talc containing amphibole was put in the tube second in order not to give the amphibole any "head-start" in sinking to the bottom.

The centrifuge method was also tested with a commercial talc. 100 FOV were counted in ten 1-mg samples according to the FDA procedure for amphibole. This was compared with 20 FOV counts on 60-mg centrifuge samples (Fig. 4). The agreement is quite good. The standard deviations were determined in two

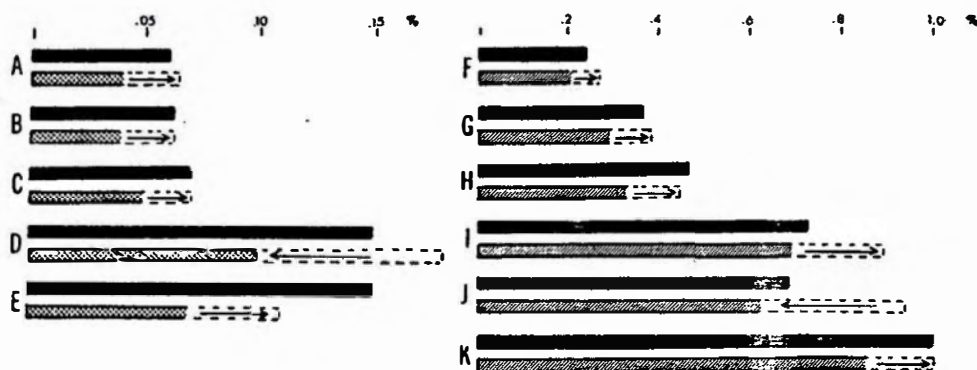


FIGURE 3. Percent tremolite in talc as determined by the centrifuge/optical method (shaded bars) compared with that actually present in experimental mixtures (black bars). The dashed part of the shaded bars indicates +2 SD (right arrow) or -2 SD (left arrow).

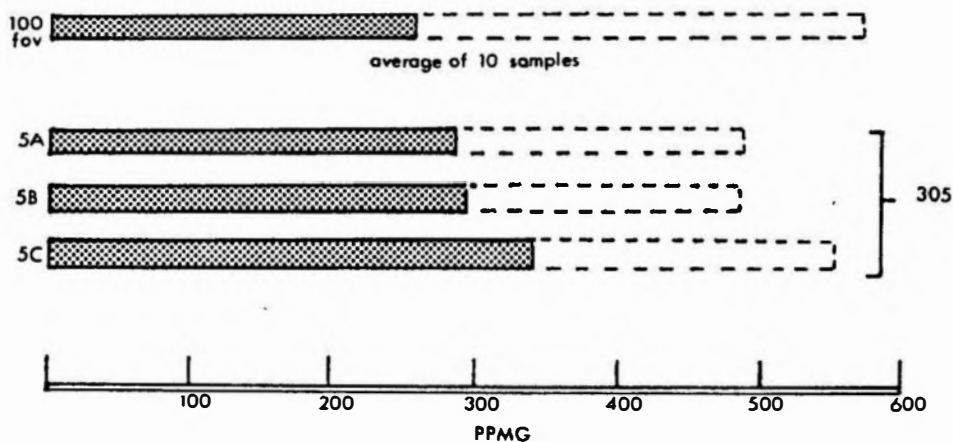


FIGURE 4. Comparison of traditional (100 FOV) count with centrifuge/optical count of same talc. The three lower bars indicate the values in particles/mg obtained by the centrifuge/optical method for three 60-mg samples. The top bar is the average of ten 100 FOV (traditional method). The dashed part of all the bars is +2 SD.

ways: for the traditional method by calculating in the usual way from multiple analyses and for the centrifuge method by means of the Poisson distribution from single counts. Standard deviations are high for the centrifuge method because of the very few particles counted. These could be decreased by making a larger count, but since the purpose of the study was to find a reasonably rapid method of monitoring amphibole content of talcs, larger counts were not generally made.

Results

High-grade talc products from five deposits in Montana, three in Vermont, and one each in North Carolina and Alabama were examined using the centrifuge/optical method. In addition, four talcs from outside the U.S. but available in the U.S. market were included in this study. Talcs from other districts in the U.S. were examined, but these talcs had grades with less stringent requirements and are not included in this report.

Results of particle counts are shown in Table 1. The FDA has equated 0.1% with 1000 particles per milligram. In order for amphibole particle content to be less than 0.1%, 20 or less particles must be observed in 20 FOV (5). Since all were well below this

value, more extensive counts were not generally made.

It should be borne in mind that the 0.1% indicated is percent by count and not percent by weight or volume. The question of the validity of this relation has been considered (5). Briefly, the relation implies (1000 amphibole particles)/(1,000,000 total particles). Counts of total particles per milligram of talc have shown that 1 million particles per milligram of talc is a low value. Most show at least 2 to 3 times this number. The only exception was a baby powder with very large flakes which showed 0.4 to 0.8 million particles per milligram. It was not clear, however, whether this was a true value or due to the problem of counting where large, flakey particles could potentially hide other particles even in the most carefully prepared samples. Using 1000 particles/mg = 0.1% would, in most samples, give a percentage value on the high side and in this sense be a conservative answer.

The counts shown in Table 1 were made of regulatory fibers i.e., aspect ratio > 3:1. In some samples there were as many or more nonregulatory particles of amphibole as regulatory fibers. The shape of the amphibole varies greatly and seems to be highly characteristic of each deposit. In Table 1, the particles having aspect ratios less than 6:1 are designated cleavages and prismatic pieces. Those greater than 6:1 and less than 15:1 are labeled

Table 1. Counts of regulatory fibers in processed talcs.

Sample	Counts, particles/mg	SD	Particle shapes	Particles/FOV ^a
A	38	25	Cleavages	3/100
B	ND ^b			0/20
C	ND			0/20
D	< 25 ^c		Cleavages	0/20
E	ND			0/20
F	ND			0/20
G	ND			0/20
H	17	17	Cleavages and needles	2/20
I	226	59	Needles and fibers	17/20 ^d
	283	100	Needles and fibers	8/20
	291	98	Needles and fibers	9/20
	341	108	Needles and fibers	10/20
	102	51	Needles and fibers	3/20
J	25	14	Cleavages	1/20
	27	27	Cleavages	3/20
K	25	25	Cleavages	1/20
L	< 10 ^c		Needles	0/20
M	39	21	Cleavages and fibers	4/20
N	25	17	Prismatic pieces	3/20
O	ND			0/20

^aFOV, fields of view.^bND, none detected.^cNo particles seen during a 20 FOV count, but some particles could be seen during a random scan of the filter. Value shown is the lower limit of detection.^dLarge sample used for this analysis (305 mg).

"needles." The remainder, which are greater than 15:1, are labeled "fibers." Whereas in many samples only a few particles were counted as shown in the right-hand column of Table 1, it should be remembered that even if only one particle was present in 20 FOV that about 300 were present on the slide. Because of the low interference by talc particles, these were seen so that it was easy to get a sense of the general particle shape.

The shape distribution of particles for several samples was determined. Figure 5 shows a photograph of a particle of tremolite in sample *I*. The particle is composed of fibrils. The length and width of 100 amphibole particles in this talc were measured. The resulting distribution of aspect ratios is shown in Figure 6. The results when compared with the aspect ratios determined for tremolite asbestos with SEM by Campbell et al. (7) show sample *I* has a distribution similar to asbestos. Sample *M* was analyzed in the same way (Figs. 6 and 7). The graph of aspect ratio versus percent is compared with Campbell's results for nonfibrous tremolite. The similarity of the curves indicates that the tremolite in this talc is of the nonfibrous type.

Because the fractions produced by centrifuge are not generally pure after a single spin-down, a sample containing a variety of particle shapes was tested to see if the aspect ratio distribution results become biased in favor of larger, chunky grains (low aspect ratio) over small, long grains (high aspect ratio). The sample used contained 6.5% tremolite, a sufficient quantity that the traditional optical method could be used to compare with the centrifuged sample. The resulting aspect ratio distribution curves (Fig. 8) do not show significant differences. With the traditional method, 69% of the amphibole particles have an aspect ratio of 3:1 or greater, whereas for the centrifuged samples the value is 64%, a variation which is not significant. The differences shown for 5:1 and 10:1 are probably due to the limited number of particles measured, in this test 100 particles in each sample.

Despite the similarity of the curves, the mean length and mean width of the amphibole particles measured using the centrifuge method are greater than those obtained using the traditional method (Table 2). Analysis of size distribution indicates that the proportion larger than 15 μ m is greater in the centrifuged sample. This difference in dimension distribution does not appear, however, to affect the aspect ratio distribution. Other investigators have found that as particles increase in length, the aspect ratio shifts to higher values (8,9). This applies to both asbestos and nonasbestiform amphiboles, so presumably the effect of centrifuging down longer particles would be to force the aspect ratio distribution peak to higher values.

Discussion

The high-grade talc powders are uniformly low in amphibole content. Counts obtained were 0 to 341 particles/mg. Indeed, talc from some districts appears to be completely free of such minerals. In those containing amphibole minerals there are two distinct types: cleavage type and asbestos type. These two types show distinctly different aspect ratio distributions as demonstrated in Figure 6 (samples *I* and *M*). The aspect ratio difference probably accounts in a large part for the higher particle count per milligram of sample *I* compared with the others which show cleavage fragments. It is easy to see that the number of particles showing greater than 3:1 aspect ratio would be greater in the former case even if the total number of particles of amphibole were equal. This observation reinforces the original decision to count particles visually rather than attempting to use X-ray diffraction. It is not wise to try to convert information on dimensions to percent by weight or volume because a few very large particles can drastically affect the resulting value. Campbell et al. (8) discuss this in some detail.

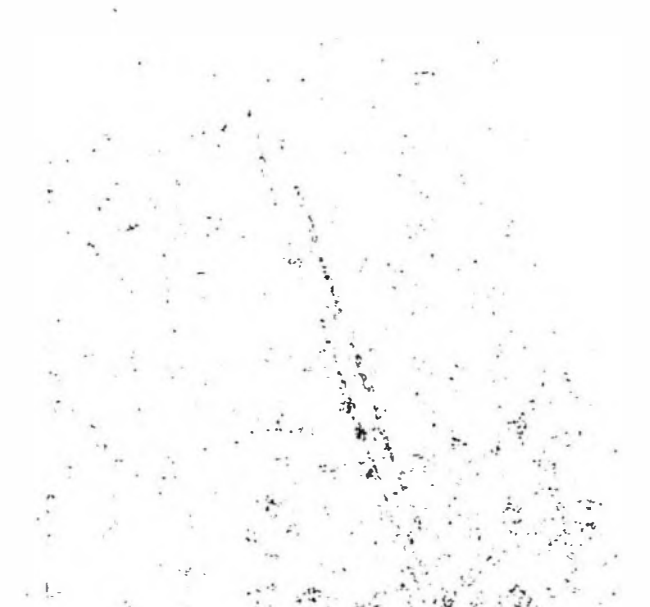


FIGURE 5. Particle of amphibole in centrifuged sample *I*. Width of view 0.07 mm and 1.584 refractive index liquid. Particle is on a membrane filter.

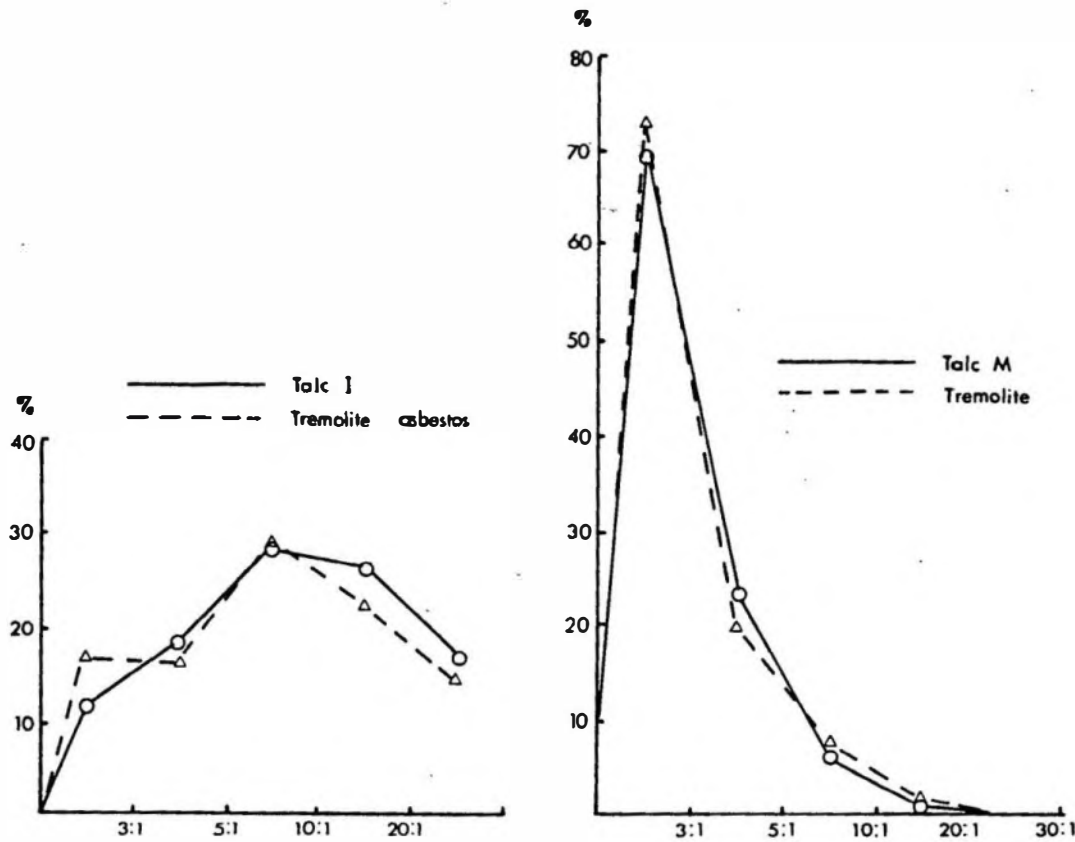


FIGURE 6. Percent amphiboles in each aspect ratio group for talc sample *I* (left) and *M* (right) compared with tremolite asbestos (7) and tremolite (nonasbestiform) (7).

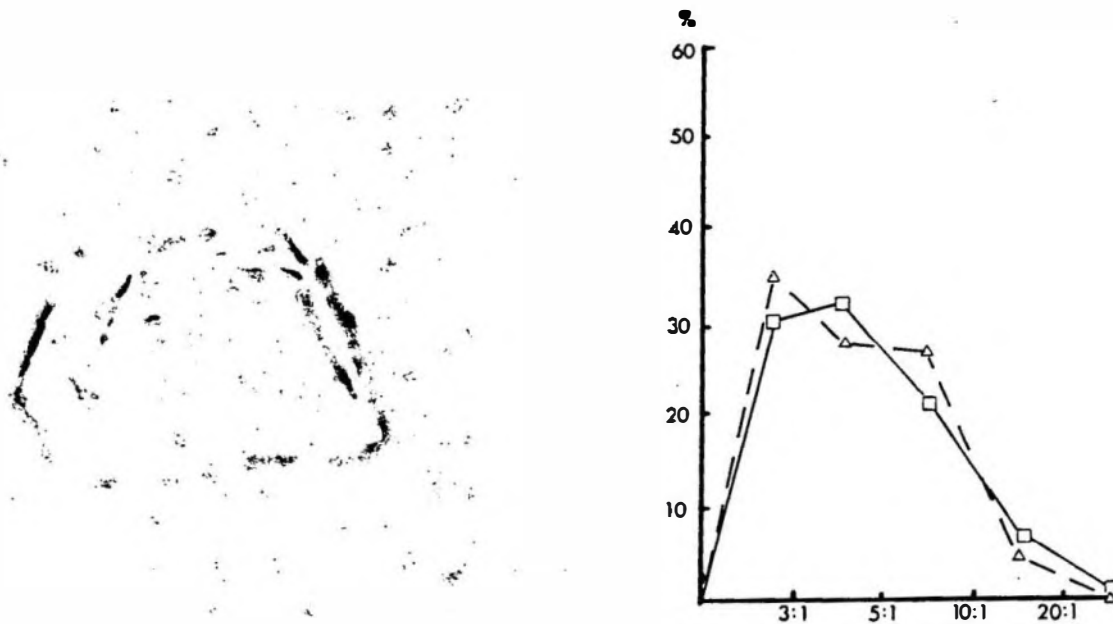


FIGURE 7. Particle of amphibole in centrifuged sample *M*. Width of view 0.07 mm and 1.584 refractive index liquid. Particle is on a membrane filter.

FIGURE 8. Percent amphiboles in each aspect group for a sample handled in two ways: solid line shows results using traditional method and dashed line shows results using centrifuge method. Dimensions of 100 particles measured for each curve.

Table 2. Summary of size and aspect ratio data used to construct Figure 8.

Method	Size, %		
	5-10 μm	10-15 μm	$\geq 15 \mu\text{m}$
Traditional	57	26	16
Centrifuge	33	27	38
	Mean length, μm	Mean width, μm	Mean aspect ratio, μm
	12.5	3.0	4.4
Centrifuge	17.5	4.7	4.6

Further, the results from this study demonstrate the utility of the centrifuge method not only for obtaining a count of particles, but also for obtaining information on the shape of particles in a population. It should be emphasized that the aspect ratio curves determined for samples *I* and *M* would have been virtually impossible to obtain using the FDA procedure. The determination would have required examining over 3000 FOV. As indicated previously, many talc flakes on edge appear to be fibers and must be examined during such a scan, making the whole job impossibly tedious.

Finally, even in those cases where one may wish to use the standard 100 FOV count, the centrifuge method offers a way to screen samples between those times when a more lengthy count is made, and it permits a double check of values so determined. In addition, the tendency to bring down a disproportional number of larger particles has the advantage that with true asbestiform amphiboles one

generally sees some particles showing bundles of fibrils which removes any doubt about the nature of the amphibole.

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- A - Italian
- B - Montana - Willow Creek
- C - Montana (Beaverhead?) Pfizer
- D - North Carolina
- E - Alabama
- F - Montana - Willow Creek
- G - Montana Floated at Albanians
(Pfizer) Beckwith?
- H - Italian
- I - Windsor - J & J JBP
- J, K, L, M - other VT deposits - m = Troy
- N - Timmins Ontario - Steetly
- O - Willow Creek - Montana Tel Co.

Exhibit 11

CYPRUS ORE RESERVE EVALUATION PRELIMINARY SUMMARY

R. C. Munro

INTRODUCTION

A complete evaluation of the CIM talc reserves is underway, but has emerged as a more complex task than anticipated. There are eighteen mining reserves to assess with at least four ore quality factors¹ to evaluate in each case, and data available from CIM is not always clear. It will take till May 15 to complete this project. Two U.S.B. senior geologists have been conscripted part time for independent reserve calculations on the more important talc deposits.

The following is a summary of our thoughts to date.

GENERAL

We have been working with Philippe Moreau of Talc de Luzenac, Ernie Reade of CIM and the CIM geological staff to determine:

- 1) How closely the real mineable ore reserves match the geologic resource numbers that have been carried by CIM.
- 2) The tons of ore (and years of production life) that are remaining in the ground at the various reserve sites and the ore qualities available in proportion to the ore requirements for the various CIM milled products.

¹*Talc content, brightness, impurities and quality.*

- 3) The related problems that exist in terms of environmental concerns, permitting, mineability and liability at each mining site.

So far, our reserve estimates in tons of mineable proven and possible ore differ in some areas from CIM's figures. These comparisons appear on the summary sheet, page 3, with comments.

Hammondsville and Beaverhead appear to have no significant economic value as reserves. The usable tonnage at the Troy deposit is substantially reduced. The Hamm deposit needs more detailed study before its future value is understood. Significant additional potential may exist at Argonaut. Yellowstone South Forty has major potential for significantly increased reserves and reduced stripping ratios.

Matching all types and volumes to various CIM milled products in some sort of material balance sheet has proven more difficult than expected. CIM data is hard to quantify and has required constant adjustment, as CIM staff strive to educate us in their rather complex "ore to product" paths. At this writing, the tonnages used and the role of imported ores need to be clarified. In spite of a significant effort and some surplus staff, the Cyprus organizational system has not enabled a clear, consistent overall picture of current ore reserve usage to emerge and be transmitted to anyone - Cyprus itself or a potential buyer.

Some problems with several of the mine reserves sites have emerged.

Fibrous minerals - tremolite and actinolite are ubiquitous in several zones of the Vermont mines. The potential problems involved with fibre in dumps, and to some degree in products, must be carefully evaluated.

ORE RESERVE COMPARISON

MINE	GEOLOGIC		MINEABLE <i>Proven & Probable</i>		COMMENT
	CYPRUS <i>(as of 12/31/90)</i>	BORAX	CYPRUS	BORAX	
Talc					
Holmes/Ward, AL	173,000	—	75,000	75,000	hard rock reserve
Argonaut, VT East	—	3,000,000	—	3,000,000	good potential but little data — an inferred reserve — DRILL?
Argonaut, VT Main	5,835,000	3,000,000	3,775,000	3,000,000	high stripping cost in early years
Black Bear	1,499,000	1,300,000	1,299,000	1,300,000	a viable reserve
Clifton	600,000		300,000	300,000	reserve not checked for mineability
Frostbite	1,400,000		650,000	650,000	reserve not checked for mineability
Hamm	6,508,000	3,060,000	3,158,000	1,952,000	need additional data to assess this reserve — As & fibre — DRILL?
Hammondsville	4,727,009		2,227,000	—	unmineable
Kelley	900,000		530,000	500,000	possible reserve
Newfane	850,000		390,000	300,000	a prospect — possible reserve
Rainbow	1,416,000	765,000	1,116,000	765,000	needs further financial evaluation — DRILL?
Troy	7,200,000	1,305,000	3,600,000	470,000	a problem reserve
Beaverhead, MT	144,000	59,000	61,000	—	not a viable reserve at today's prices
MP Claims	84,000		58,000	58,000	prospect — possible reserve
Yellowstone — S40	19,244,000	14,802,000	6,814,000	7,131,000	recovery problem but good ore body with excellent additional potential — DRILL?
Yellowstone — N. Main	2,533,000	962,000	1,066,000	933,000	may phase out with S40 development
Yellowstone — Other	473,000	N/D	—	unknown	no significant reserve potential apparent
KR Prospect, CA	280,000		—	280,000	a prospect in sensitive area
Red Hill/Main	366,000	375,000	116,000	150,000	adequate tonnage for needs
Van Horn, TX	—		—	—	not reviewed — poor quality
Chlorite					
Antler	322,000		280,000	275,000	actual recovery needs to be defined
Cottonwood				—	low brightness prospect
Fair Lady				—	untested
TOTAL	54,554,009	28,628,000	25,515,000	21,139,000	

Arsenic minerals, both insoluble sulphides and the more soluble arsenate minerals are problems that restrict productivity in an effort to keep product under 3 ppm soluble As in the West Windsor and Johnson Mills. High arsenic restricts product acceptance and lays a basis for future possible environmental and permitting problems.

Also in Vermont, the underground Windham Mine has been identified as the site of a PCB transformer left on the second level of the flooded workings.

Permitting is in dispute at the Ludlow East Argonaut operation where stripping and mining are underway. At the major new reserve in the Ludlow area, the East Argonaut zone, the mining permit has been challenged by a nearby homeowner and supporters.

Ore stock piles in inventory need thorough checking. Troy ore stockpiles are described in inventory as 93,000 tons. Operations staff claims 70,000 tons of which only 11,200 tons are judged to be suitable for current Johnson mill feed, with perhaps 13,000 tons of fines when dry. Johnson Mill inventory is given as 7,000 tons. Plant Manager Ed Wissle says 3,500 tons. This degree of error at Troy-Johnson suggests that all stockpiles be investigated before the ore stockpile inventory values are accepted. Stock piles inspected at Alpine appear to meet claim.

WESTERN MINES

California

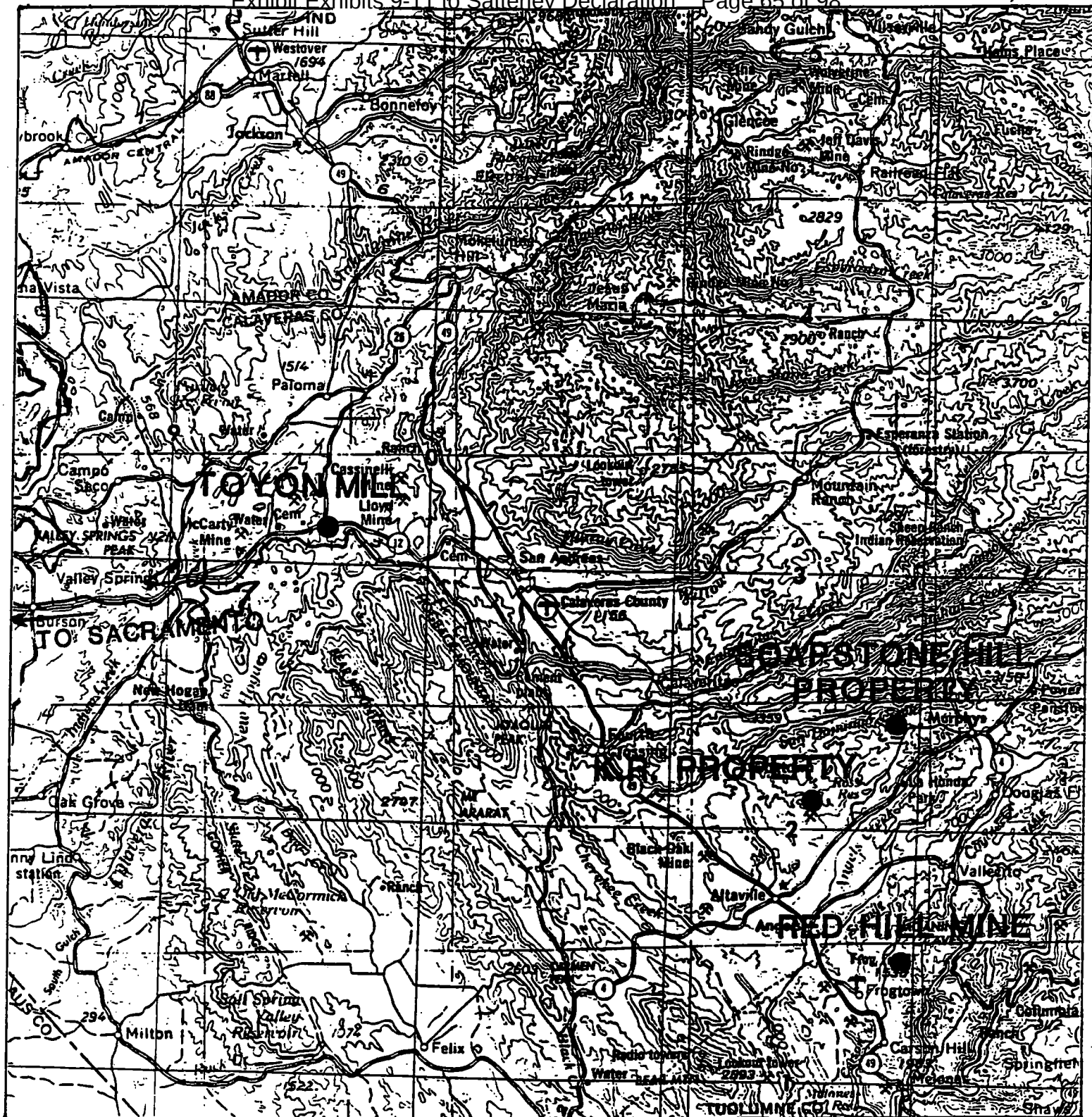
The small, but aggressively managed, Western Source operation produces limited use dry ground product for roofing shingles from the Red Hill Mine. The Red Hill

deposit is a tabular deposit of talc carbonate schist some 50' wide with 20' of better grade material in the footwall. It is estimated to be over 1,200' in length and dipping $\approx 50^\circ$ to the NE. The deposit runs about 50-60% talc with higher talc content in some areas of the narrow footwall zone. Fe oxide stains the more shallow ores. GEB on currently mined ore runs 75% (too high in iron for ceramics and not bright enough for paint). CIM calculates a mineable reserve of 366,000 tons. USB calculation provides for a similar tonnage of 375,000 tons to a depth of 100', although this may require a stripping ratio of greater than 1:1 to access the better talc. XRD analysis sheets examined showed no fibrous minerals detected in the Western Source product.

An additional undeveloped reserve of talc carbonate schist is held on a lease in force until the year 2009 at the KR property. Trenches and several drillholes have generally indicated a large zone of banded talc carbonate schist with bands of micaceous schist quartz veins. A small area where soil was stripped in the past has been recovered. The KR property offers a 300,000-ton potential, providing future urban development in the area permits the opening of a talc mine at this location.

The Toyon Mill is permitted and in a reasonable location for access to the northern California market and there has been some half-hearted experimentation with milling Montana ores there for an expanded market line of Western Source products. Toyon might also treat any Nevada chlorite developed at Fair lady in the future if it could be economically transported.

Other California deposits include the Talc City claims, claims near Death Valley (sites of past production) and Eagle deposit in Saline Valley currently intermittently



LOCATION OF C.I.M. PROPERTIES CALAVERAS COUNTY, CA.



produced by a minor lessee. None of these offer valuable reserve potential, but some may have a glimmer of environmental liability with stockpiled tremolite rich ores. Reade promises a report on these locations.

Montana

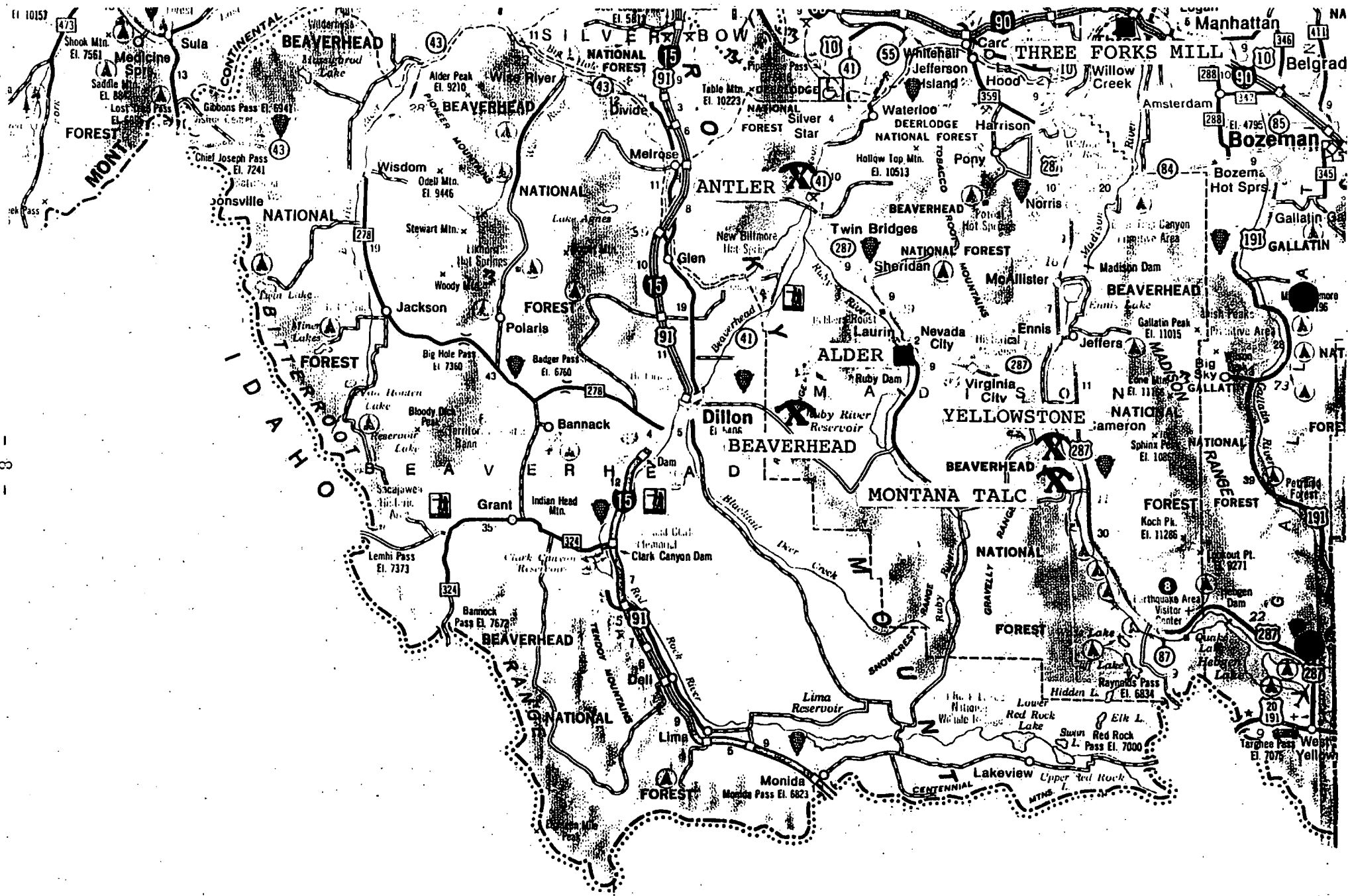
Yellowstone South Forty

CIM's most important (western) talc reserve is the Yellowstone South Forty pit. Recognized in 1987 and subsequently explored by more than 100 drill holes (assay data on about half of these). The reserve emerges as a major world talc resource.

The CIM ore reserve calculations completed and reassessed in January of this year indicate reserves as follows:

Geologic Reserve of 9,477,000 tons of which 6,813,943 tons are classified as proven and probable mineable tons at a waste to ore ratio of 4.5:1. 75% of this reserve is estimated to be of ore grading + 90% talc.

Further, CIM have estimated a **Recoverable Reserve** that accounts for mining and sorting plant recoveries. This is accomplished by the application of recovery factors of 30% to 66% on each of the 12 ore types in the reserve calculation. CIM estimates the "recoverable reserve" at 3,898,220 tons of total "recoverable talc" or 57% of the mineable reserve. This is an approximately 22 year mine life at the current consumption rate.



USB's independent ore reserve calculation has identified a proven and probable mineable reserve 7,131,370 tons at a 5.09:1 waste to ore ratio within a 15,000,000 ton geologic resource.

Recoverable reserves for us become a problem with the acceptance of CIM's theoretical, calculated 57% recovery factor which is not supported by recent recoveries of concentrate in the mine and sorting plant.

Based on annual production records, pages 10-13, recoveries of concentrate (to the mill) from ore to the sorting plant during 1989 (21%), 1990 (29%) and 1991 (26%) yielded a weighted average of 23.5%. Corrected 1991 figures for sorter recoveries were provided and indicate a 30% recovery for 1991, see flow sheets page 15-17. Applying a 30% recovery to the 7,131,000 mineable reserve = 2,139,000 tons of recoverable talc concentrate, -10 year mine life at current concentrate production rate. On this basis, recoverable talc is 5.0% of the total rock mined (ore and waste); the approximate average mined tons to product tons ratio for the past 10 years, see page 18.

When asked about the large discrepancy between the actual historical recoveries and the newly calculated theoretical recoveries, CIM staff indicated that they expected and calculated better recoveries for the future as production moved into the newly opened high grade faces of the South Forty pit.

Inspection of the drill sections confirms the view that substantial tonnage of high grade talc lie in the current South Forty pit floor. However, much of the plant losses are in screenings (38%) and unless most of these were sold as CIMCOAT or MISTRON II products, it seems unlikely that the projected 57% recoveries will

END OF MONTH REPORT DECEMBER 1991

MINE PRODUCTION

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YTD	1989	1988
WASTE	229,221	172,677	123,655	113,459	245,380	289,009	294,907	260,358	297,223	348,404	283,816	195,153	2,853,262	3,343,600	4,713,380
ONE	59,487	62,606	65,217	88,855	41,029	27,453	7,697	22,261	8,289	32,141	4,531	3,078	422,842	409,452	505,350
IRE	73,511	66,061	68,406	56,548	70,698	54,081	58,908	58,417	40,150	61,872	38,615	27,472	874,737	822,930	1,002,790
HED FD/STPL	1,682	0	901	0	2,589	3,939	457	96	2,368	0	0	0	12,032	59,835	97,645
IS FD/STPL	65,060	59,085	64,027	51,370	58,029	44,253	52,424	50,225	28,374	55,184	33,527	24,595	586,153	819,500	620,305
IS FD DIRECT	2,976	4,814	3,478	5,178	10,078	5,889	6,027	8,096	9,280	6,688	4,608	2,223	69,335	143,865	207,345
DIRECT SHIP	3,793	2,162	0	0	0	0	0	0	0	0	480	654	7,089	0	0
IT TALC MINED	0	0	128	0	0	2,571	0	0	0	0	5,621	517	8,837	15,440	0
SOUTH FORTY PIT															
SOUTH FORTY														125,038	
ENCH 8126	47,159	11,767	62,112	4,000	0	0	0	0	89,378	800	384	0	508,550		
ENCH 8100	34,483	48,273	83,728	96,909	168,491	17,041	2,098	0	36,319	112,319	73,802	89,077	600,313		
ENCH 6075	13,658	45,443	10,871	74,717	81,591	9,781	19,314	83,483	69,142	51,479	8,263	0	211,370		
ENCH 6050						14,944	36,720	32,822					144,000		
NORTH FORTY PIT															
NORTH FORTY														156,658	
ENCH 6250	135,524	20,758	0	0	376	0	0	0	0	0	0	0	279,057		
ENCH 6225	131,427	144,288	3,344	0	0	0	0	0	0	0	0	0	219,242		
ENCH 6200	0	29,728	127,226	62,192	96	0	0	0	0	0	0	0	99,249		
ENCH 6175		4,089		6,208	29,929	49,734	9,209	0	0	0	0	0	7,488		
ENCH 6150							7,488	0	0	0	0	0	0		
NORTH MAIN PIT															
NORTH MAIN														34,670	
ENCH 6140					20,792	13,878	0	0	0	0	0	0	475,903		
ENCH 6115					55,830	257,769	162,304	0	0	0	0	0	482,290		
ENCH 6090						7,426	124,299	242,811	92,240	4,804	0	10,530	208,144		
ENCH 6065								11,950	58,585	213,238	2,373	0	293,832		
ENCH 6040										59,599	186,858	47,375	170,837		
ENCH 6015				14,836	0	0	0	0	0	0	57,282	98,719	3,950,641	4,591,422	6,221,500
TOTAL MINED	382,219	301,344	257,278	258,802	357,105	370,543	381,512	341,038	345,682	442,417	326,962	225,701	178,644	200,110	212,380
IONS PRODUCT	18,967	14,255	14,374	16,979	15,951	14,005	14,019	17,020	13,680	17,000	13,475	10,919	26%	24%	21%
STRIPPING													21:1	22:1	28:1
RATIO	20:1	20:1	17:1	14:1	21:1	25:1	25:1	19:1	24:1	25:1	23:1	20:1	← w/o cement		
	23%	22%	22%	30%	23%	26%	24%	27%	34%	27%	35%	39%			

MINING HIGHLIGHTS

- 1) All production goals were met or exceeded in 1991. Expense goals were also met.
- 2) Diesel fuel prices fluctuated from a low of \$0.59 to a high of \$0.91 per gallon. Diesel usage in 1991 decreased by 81,560 gallons from 1990 usage.
Gas prices varied from a low of \$1.00 to a high of \$1.21 per gallon. Gasoline usage was down 7,500 gallons from 1990 usage.
- 3) Pit personnel did an excellent job of keeping costs to a minimum.

MINE PRODUCTION

END OF MONTH REPORT

JANUARY 1992

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	1992 YTD	JAN 1991
WASTE	208,914												208,914	229,221
BONE	2,514												2,514	59,487
ORE	33,713												33,713	1
DIRECT SLAB	258												258	N/A
MS FD/STPL	20,438												20,438	65,060
MS FD DIRECT	768												768	2,976
DIRECT SHIP	9,215												9,215	3,793
OTHER PILES	3,036												3,036	N/A
MT TALC MINED	2,048												2,048	0
SOUTH FORTY														
BENCH 6075	22,541												22,541	13,656
BENCH 6050	46,281												46,281	0
NORTH MAIN														
BENCH 6090	15,632												15,632	0
BENCH 6065	0												0	0
BENCH 6040	0												0	0
BENCH 6015	113,925												113,925	0
BENCH 5990	46,762												46,762	0
TOTAL MINED	245,141	0	0	0	0	0	0	0	0	0	0	0	245,141	362,219
TONS PRODUCT	18,586												18,586	16,000
STRIPPING														
RATIO	12:1	55% w/o CIMCOAT SULD												
		61% w/ CIMCOAT SULD												

$\left(\frac{18,586}{33,713} \right)$ } 100% NORTH MAIN PIT
 $\left(\frac{20,445}{33,713} \right)$

MINING HIGHLIGHTS

- The 6015 bench of the North Main Pit is nearly exhausted and the 5990 bench is being developed. MS/SPS are now direct ship to.
- The South 49 PM bench 2005 is out of North Main Pit and will be mined more soon.

2nd

2nd DATA REVIEW

MS/SPS PRODUCTION

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YTD	1990
FEED	56,391	58,344	64,627	59,075	52,173	39,039	47,352	48,617	29,952	50,098	38,305	26,113	570,086	672,982
PRODUCT	11,940	14,201	13,855	16,288	15,772	13,810	13,995	17,020	13,386	17,000	13,443	10,353	171,063	156,200
SCREENINGS	22,711	24,756	22,478	23,116	17,465	11,601	19,074	18,363	14,409	18,480	14,811	10,011	217,273	222,623
OVERSIZE	3,420	5,564	3,230	2,635	2,285	1,645	1,340	769	70	680	336	190	22,259	42,361
WASTE	18,320	13,823	25,066	17,036	16,651	11,983	12,943	12,474	2,087	13,738	9,721	5,649	159,491	250,570
MS FEED	25,242	23,079	29,934	25,457	25,744	23,108	25,371	28,735	13,741	24,855	17,766	11,916	272,948	298,159
MS PRODUCT	9,993	11,349	11,539	13,126	13,110	12,744	13,591	15,576	12,611	15,133	11,451	9,037	149,260	116,436
MS WASTE	15,249	11,730	18,395	12,331	12,634	10,364	11,780	11,159	1,130	9,722	6,315	2,879	123,688	181,833
RECOVERY	40%	49%	39%	52%	51%	55%	51%	58%	92%	60%	64%	76%	57%	%
TONS/SORTER HOUR	5.3	7.6	5.7	7.8	6.5	7.0	7.3	8.6	10.6	8.8	10.0	10.3	7.9	8.6
SPS FEED	6,018	4,845	8,987	7,867	6,679	2,885	1,587	2,759	1,732	5,883	5,398	4,086	57,606	136,938
SPS PRODUCT	1,947	2,852	2,318	3,182	2,662	1,068	404	1,444	775	1,867	1,992	1,318	21,803	39,764
SPS WASTE	3,071	2,093	6,671	4,705	4,017	1,819	1,183	1,315	957	4,016	3,406	2,770	35,803	97,194
RECOVERY	39%	58%	26%	40%	37%	40%	26%	52%	45%	32%	37%	32%	39%	29%
TONS/SORTER HOUR	3.1	6.2	4.9	7.3	6.5	4.5	3.3	11.2	11.8	8.6	4.6	4.0	6.3	4.2
* REPAIR OVERSIZE THROUGH PLANT TO INCREASE RECOVERY *														
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YTD	1990
SHED PRODUCTION														
FEED	1,402	68	867	78	1,730	1,071	204	0	2,082	0	0	0	7,500	78,407
PRODUCT	1,234	54	501	60	179	195	24	0	294	0	0	0	2,541	39,835
WASTE	168	12	69	18	1,551	876	180	0	1,788	0	0	0	4,662	8,574
SCREENINGS	0	0	297	0	0	0	0	0	0	0	0	0	297	248
RECOVERY	88%	82%	57%	77%	10%	18%	12%	0%	14%	0%	0%	0%	33%	3%
TONS/SORTER HOUR	3.1	3.3	3.6	3.7	8*	1.2*	1.0*	0.0	.6*	0.0	0.0		2.2	3.2

* SORTING CONFIGURATION CHANGED TO PIT SORT STYLE FOR 39 MATERIAL

MS/SPS PRODUCTION

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YTD	1990
FEED	58,391	58,344	64,627	56,174	52,173	48,232	54,909	50,230	36,684	56,706	37,698	24,939	597,107	672,982
PRODUCT	11,940	14,201	13,855	16,288	15,772	13,810	13,995	17,020	13,386	17,000	13,443	10,353	171,063	156,200
SCREENINGS	22,711	24,756	22,476	23,116	17,465	11,601	19,074	18,363	14,409	18,480	14,811	10,011	217,273	222,623
OVERSIZE	3,420	5,564	3,230	2,635	2,285	1,645	1,340	760	70	880	330	100	22,259	42,361
WASTE	18,320	13,823	25,068	14,135	16,472	17,981	20,500	14,087	8,819	20,346	9,114	4,475	183,138	250,570
MS FEED	25,242	23,079	29,934	25,457	25,744	23,108	26,718	26,735	13,741	27,218	17,766	11,916	278,658	298,159
MS PRODUCT	9,993	11,349	11,539	13,126	13,110	12,744	13,591	15,576	12,611	15,133	11,451	9,037	149,260	116,436
MS WASTE	15,249	11,730	18,395	12,331	12,634	10,364	11,780	11,159	1,130	9,722	6,315	2,879	123,688	181,833
RECOVERY	40%	50%	26%	52%	51%	54%	49%	58%	92%	56%	64%	76%	56%	39%
TONS/SORTER HOUR	5.3	7.6	5.7	7.6	6.5	7.0	7.3	8.6	10.5	8.8	10.0	10.3	7.9	6
SPS FEED	5,018	4,945	9,000	7,887	7,148	2,685	1,587	2,759	1,732	5,883	5,398	4,086	58,088	136,938
SPS PRODUCT	1,947	2,852	2,316	3,162	2,662	1,066	404	1,444	775	1,867	1,992	1,316	21,803	39,764
SPS WASTE	3,071	2,093	6,671	4,705	4,486	1,619	1,163	1,315	957	4,016	3,406	2,770	36,272	97,194
RECOVERY	40%	50%	26%	40%	54%	40%	26%	52%	45%	32%	37%	32%	39%	29%
TONS/SORTER HOUR	3.1	6.2	4.9	7.3	6.5	4.5	3.3	11.2	11.8	8.6	4.6	4.0	6.3	4.2
* RERUN OVERSIZE THROUGH PLANT TO INCREASE RECOVERY *														
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YTD	1990
SHED PRODUCTION														
FEED	1,372	66	867	78	1,730	1,071	204	0	2,082	0	0	0	7,470	78,407
PRODUCT	1,234	54	501	60	179	195	24	0	294	0	0	0	2,541	39,835
WASTE	168	12	69	18	1,551	876	180	0	1,788	0	0	0	4,662	8,574
SCREENINGS	0	0	297	0	0	0	0	0	0	0	0	0	297	27,248
RECOVERY	88%	82%	57%	77%	10%	18%	12%	0%	14%	0%	0%	0%	33%	53%
TONS/SORTER HOUR	3.1	3.3	3.6	3.7	8"	1.2"	1.0"	0.0	6"	0.0	0.0		2.2	3

* SORTING CONFIGURATION CHANGED TO PIT SORT STYLE FOR 39 MATERIAL

PLANT PROCESSING HIGHLIGHTS

- 1) All of the production and cost goals have been exceeded or met for 1991.
- 2) 1991 was a successful year for team departmental growth.
- 3) The biggest morale booster was the new stretch and exercise program.

be realized without other changes. Nothing we have seen in the Yellowstone records would suggest past mechanized sorter recoveries in this range.

Projected ore types within the Yellowstone S40 are as follows, with a +90% talc ores at +82 GEB, comprising 66% of the deposit.

			%Total
+90% Talc	+ 88 GEB	684,600	9.6%
+90% Talc	82-87 GEB	3,480,050	4.8%
40-90% Talc	+ 88 GEB	42,790	0.6%
40-90% Talc	82-87 GEB	969,930	3.6%
+90% Talc	Unknown brightness	1,540,350	21.6%
40-90% Talc	Unknown brightness	413,650	5.8%
		7,131,370	

Dramatic potential for increased reserves exists with approximately 2 million tons within the planned pit, offering a decreased stripping ratio and outside the planned pit there is, in the north extension and at depth, the potential for another 5 million tons.

Additional potential for new ore probably exists in a parallel N-S zone to the west of the known S40 ore body. This could bring the potential Yellowstone reserves to the 25 million ton range (see page 19).

YELLOW STONE MINE PRODUCTION

	SOUTH FORTY		NORTH MAIN		NORTH FORTY	
	TONS	%	TONS	%	TONS	%
WASTE	965,203	66.78	1,492,343	85.60	395,716	54.22
BONE	153,576	10.63	93,866	5.38	141,706 *	19.42
ORE	326,492	22.59	157,467	9.03	192,410	26.36
TOTAL MINED	1,445,271	%	1,743,343	%	729,832	%
		W/O		W/O		W/O
		3.43:1		10:1		2.79:1

676,369
7,089
Total Ore 683,458

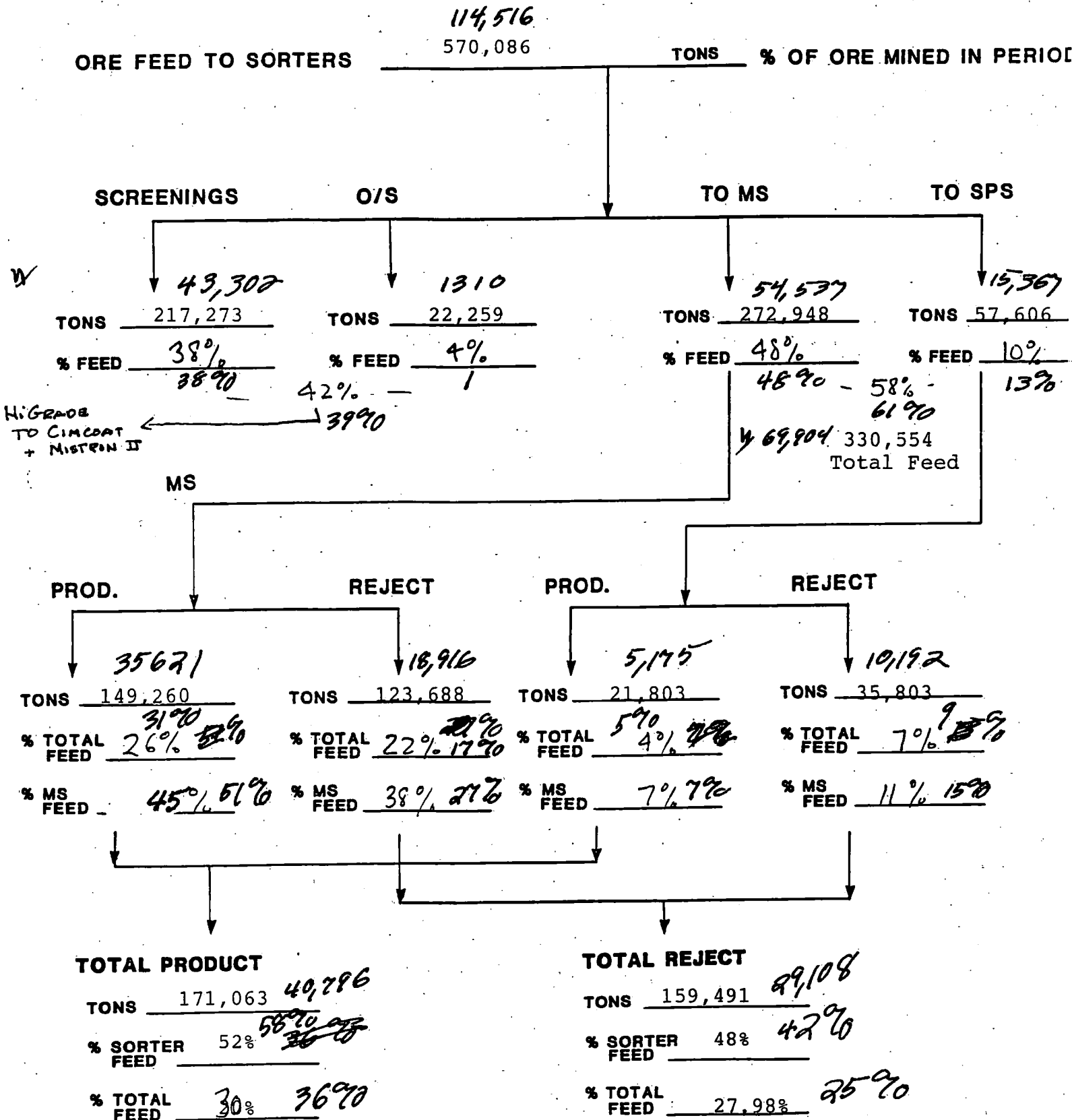
Total Rock Mined 3,918,446

TOTAL MINED	TONS	% TOTAL ROCK	% TOTAL ORE
TOTAL WASTE	2,853,262	72.81	
TOTAL BONE	389,148	9.93	
TOTAL ORE	676,369	17.26	
ORE SHIPPED TO 3 FORKS	(7,089)		
ORE SHIPPED TO MS/SPS			
TOTAL W/O Incl. bone as waste	4.79:1		

RCM

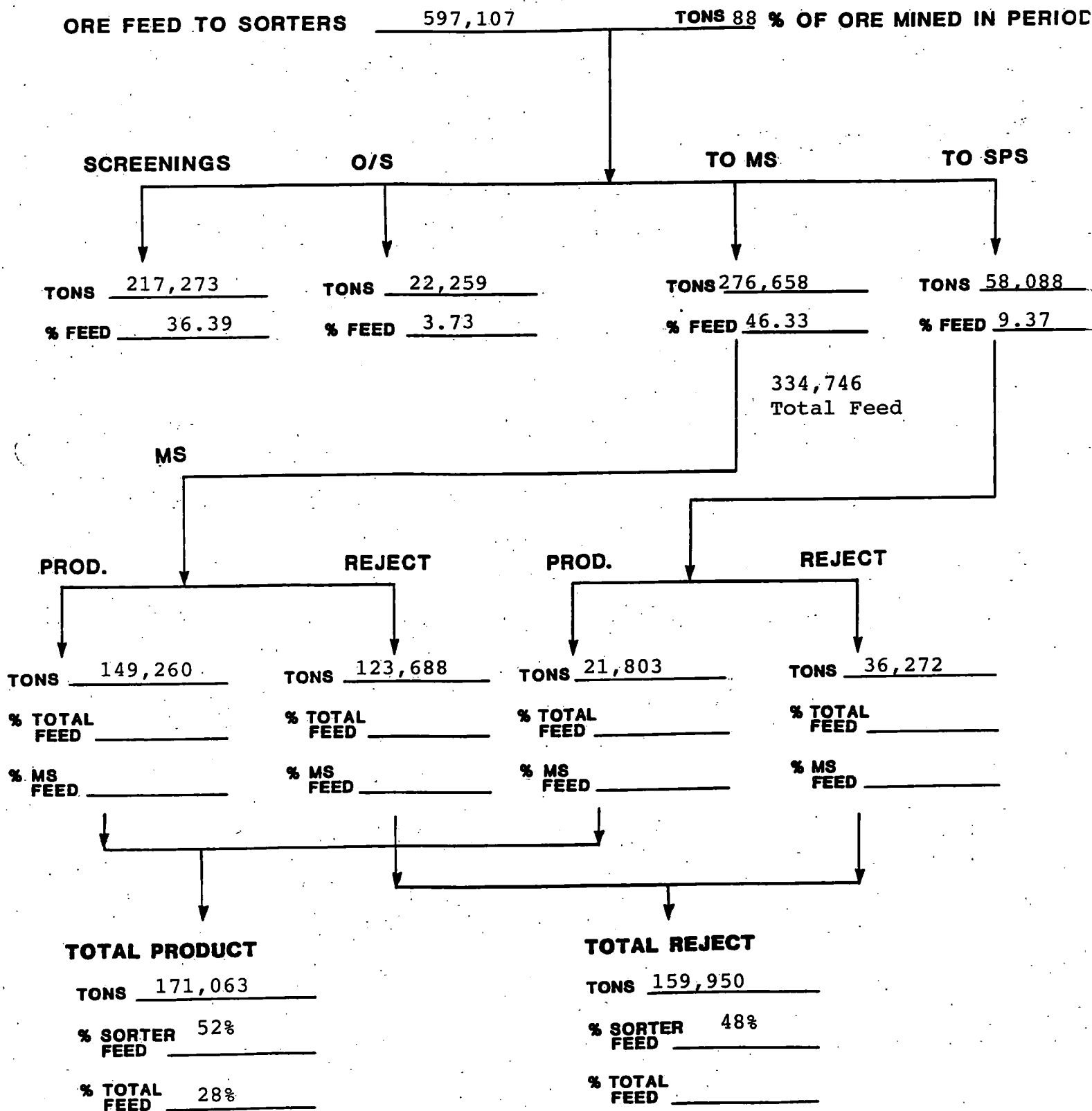
PERIOD 91 2ND FIGURES

YELLOWSTONE MS/SPS PLANT



PERIOD 91 1ST FIGURES

**YELLOWSTONE
MS/SPS PLANT**

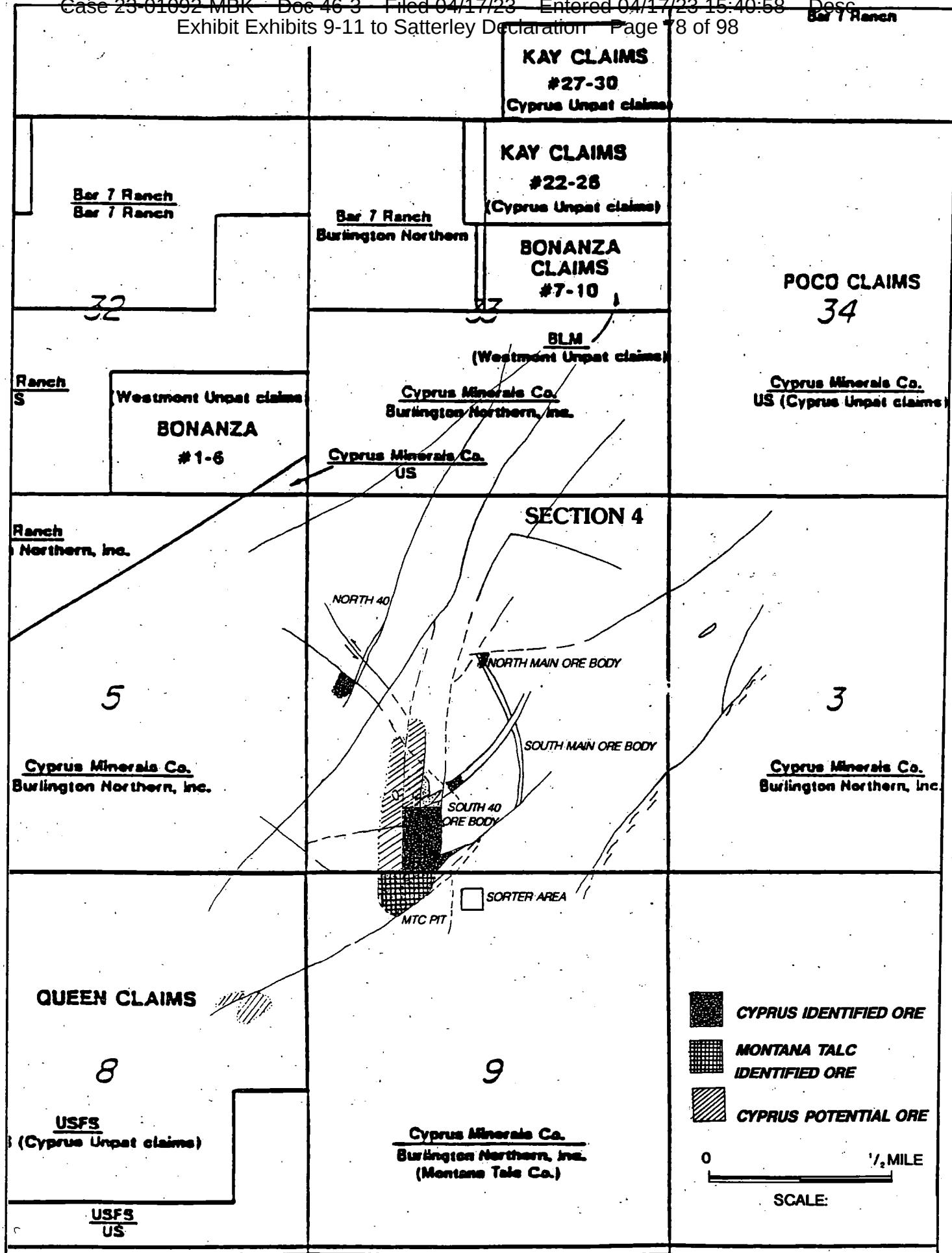


YELLOWSTONE MINE PRODUCTION

YEAR	TOTAL TONS MINED	TOTAL TALC PRODUCED	CASH COST ¢/C OF TOTAL MINED.
* 1950 - 1954	118,000	20,000	16.91
* 1955 - 1960	213,000	36,000	16.90
* 1961	41,000	7,000	17.07
* 1962	47,000	8,000	17.02
* 1963	59,000	10,000	16.95
* 1964	71,000	12,000	16.90
* 1965	89,000	15,000	16.85
* 1966	118,000	20,000	16.95
* 1967	148,000	25,000	16.89
* 1968	197,000	33,206	16.86
* 1969	277,000	46,752	16.88
* 1970	306,000	51,665	16.88
* 1971	320,000	54,098	16.91
1972	267,581	53,110	19.85
1973	265,607	63,239	23.81
1974	469,908	79,405	16.90
1975	405,862	41,229	10.16
1976	554,431	73,510	13.26
1977	885,514	94,180	10.64
1978	861,728	88,055	10.22
1979	669,492	108,568	16.22
1980	920,312	102,929	11.18
1981	1,892,258	99,230	5.24
1982	1,643,215	90,936	5.53
1983	819,000	75,000	9.16
1984	1,809,000	101,000	5.58
1985	2,181,000	137,000	6.28
1986	3,154,000	140,000	4.44
1987	2,838,000	109,000	3.24
1988	4,026,000	103,000	2.56
1989	6,222,000	212,000	3.41
1990	4,591,000	200,000	4.36
1991	3,951,000	181,000	4.58
	40,431,000	2,551,000	

* ESTIMATES

Figure 4.1



YELLOWSTONE RESERVE POTENTIAL

Yellowstone North Main Deposit

The North Main open pit exploits a north-south striking, west-dipping tabular deposit of relatively pure talc. The deposit has supplied mill feed for the past 10 (?) years and carried the Yellowstone operation during transition of mining from the South Main and North Forty to South 40 pits. Currently, a sizable percentage of the light-colored talc mined at Yellowstone is extracted from the North Main pit. The North Main deposit will continue to be an important source of high-GEB ore until the South 40 pit is fully developed.

CIM has calculated a geologic talc reserve here of 2.53 MM tons. Of this total, they classify 1.07 MM tons as minable. After applying losses resulting from mining and sorting, CIM projects 0.47 MM tons of combined recoverable product from the North Main deposit. A waste-to-product ratio of 13.56:1 is anticipated. CIM hopes to recover 166,300 tons (36%) of product 39 (>88 GEB); 290,000 tons (62%) of product 40/41 (82-87 GEB); and 9625 tons (2%) of product 50 (78-81 GEB).

U.S. Borax in-place ore reserve calculations for the North Main deposit show 0.93 MM tons of combined minable talc at a waste-to-ore ratio of 4.20:1. Calculation of reserves were made by extrapolation of measured cross-sections upon which pit slopes, current topography and drill-defined ore zones were plotted. Since minable ore is intersected in only 7 drill holes having brightness analyses, it is difficult to say with any certainty what percentage of ore will be suitable for specific products. Available data only shows that projected ore will generally meet minimum product 40/41 specifications (>82 GEB).

Beaverhead

The Beaverhead deposit is a narrow high grade talc seam exploited for its cosmetic grade talc for the past 20 years with the open pit reaching economic limits in 1987 (when the w/o ratio reached 45:1). The past 5 years have seen continued underground development of the talc zone at depth.

The 500' long talc zone consists of a series of various lenses and bands of variable quality talc with magnesite and chlorite with 10' to 40' (average 18') thick meandering seams of high purity cosmetic grade talc grading 94% with an 87-92 GEB, the basis for the current mining activity.

Production has declined over the past 5 years from 16,000 tons in 1989 to 12,000 tons in 1991. Planned production for 1992 is 8,000 tons. Narrow working faces, poor mine stability, back filling requirements, transport costs, small reserves and limited production rates make this an increasingly expensive ore source. Costs given vary from \$107.00 to \$115.00 per ton, probably \$115.00 delivered to Three Forks mill. Beaverhead costs the Alpine Alabama Mill \$175.00/ton.

Beaverhead ore is being supplanted by imported Australian material delivered to Three Forks for a reported \$125.00 per ton and to Alpine for \$147.00/ton. I would be surprised if much of the small remaining reserve at Beaverhead would be seriously considered for future mining.

Remaining geologic reserves for Beaverhead ore given by CIM as 144,000 tons. Mine management estimates 61,000 tons of recoverable ore is available.

Using a 550' strike length, a 16' average width, a 120' down-dip extrapolation, with 80% mine recovery and assuming 1/3 (east side) is chlorite low grade, yields a 59,400-ton reserve of which perhaps 25,000 tons is available with minimal development.

Chlorite

Antler

The Antler Mine produces approximately 10,000 tons per year for distribution from the Three Forks Mill.

Ore reserves are given as 143,000 tons of +90% chlorite (with an estimated 80% recovery) and 134,000 tons of 80%-90% chlorite (with 30% recovery) with a waste to ore ratio of 4.4:1. This provides a theoretical recovery of 50%.

In 1991, 2,336 tons of +90% ore and 12,604 tons of 40%-90% ore yielded 10,000 tons of product for Three Forks indicating an overall recovery of 66%. However, normal waste and stripping was 136,190 tons yielding a 9:1 waste ore ratio and a 15:1 ratio of total mined rock to product shipped.

In addition, special campaign stripping removed another 495,921 tons of stripping. Further work is needed to fully understand the material balance of the Antler ore body.

Cottonwood Canyon

At Cottonwood, limited exploration has outlined an interesting chlorite prospect with good tonnage potential given at 250,000 tons. Chlorite encountered so far is darker than Antler but could be used for blending.

Fair Lady

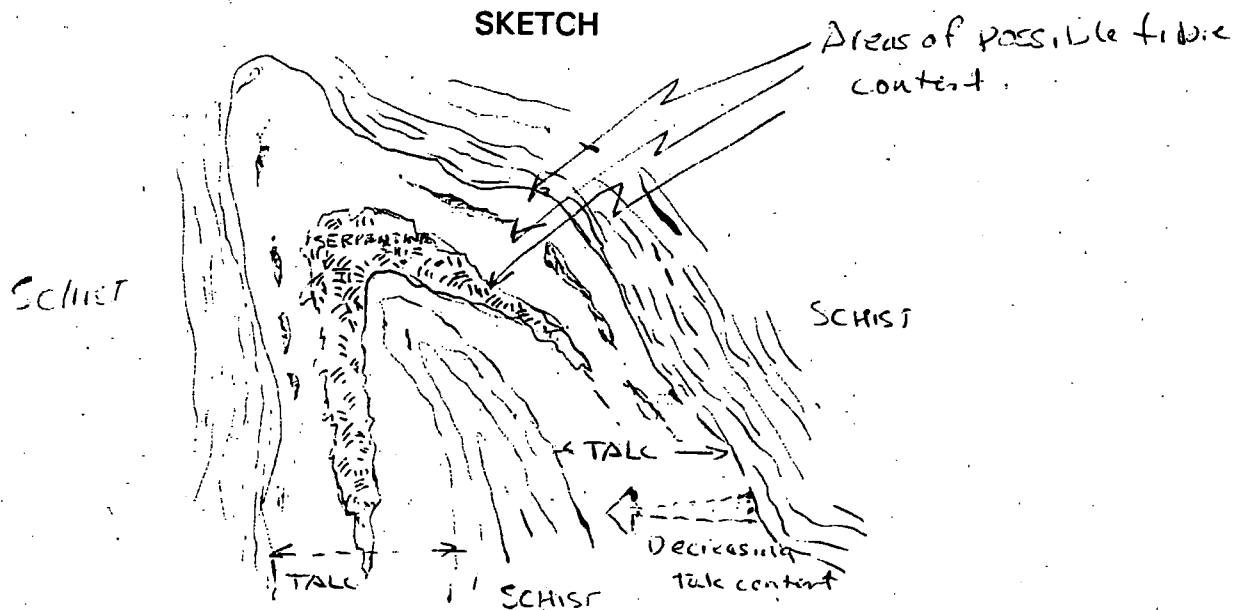
This chlorite prospect near Lida Junction, Nevada was recently optioned. Although not an ideal location, the Fair Lady offers prospects for additional chlorite reserves.

Vermont

Two dry mills and two floatation plants produce products from ore currently shipped from 5 mines operating at three Vermont locations. The ores from the producing deposits provide feed for the dry mills at Columbia and Chester and for floatation plants at Johnson and West Windsor. Other mining sites that are listed as Cyprus assets are in reality deposits that were mined in the past but are now regarded as mined out or are uneconomic at this time or are undeveloped properties with some reserve potential for the future).

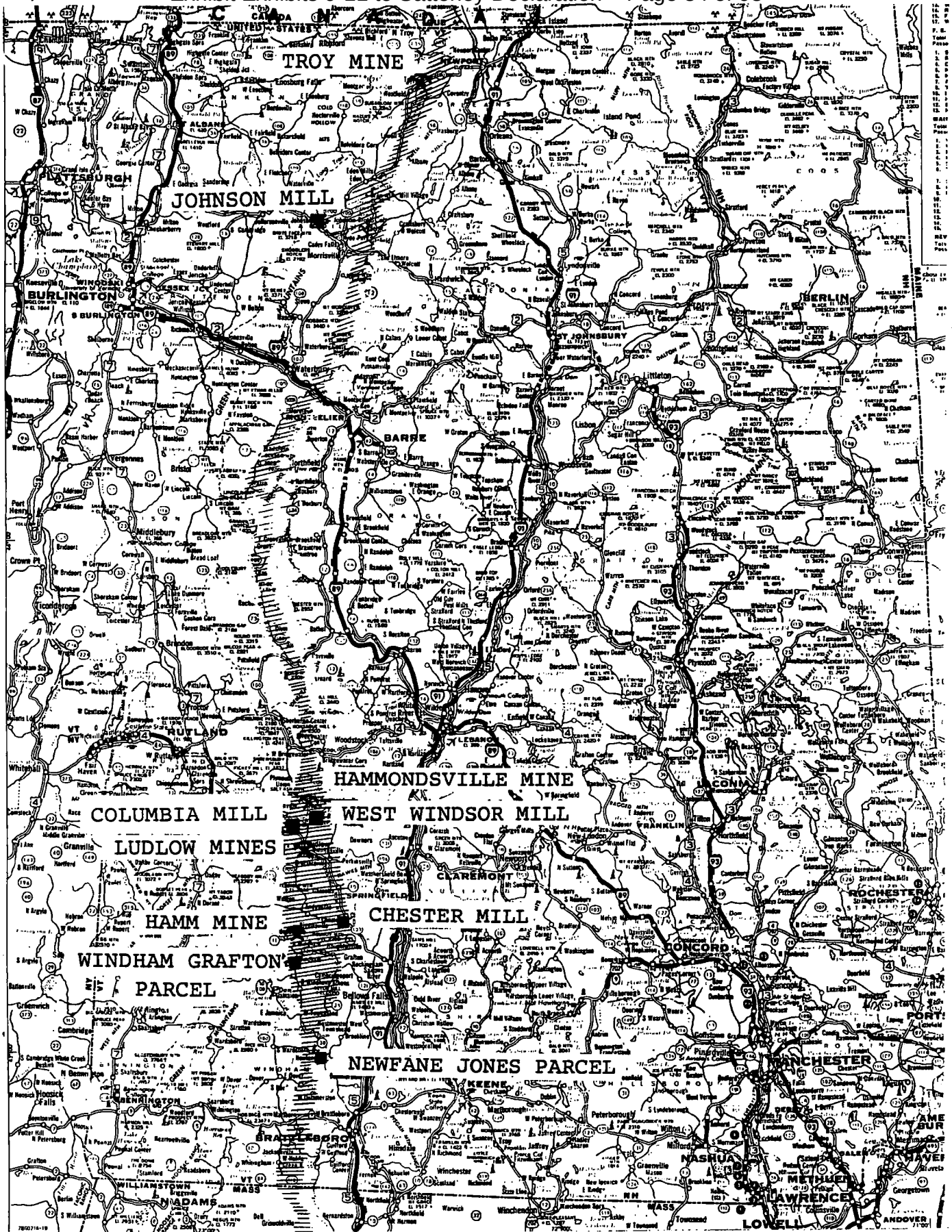
The area containing these reserves is all within the Appalachian Ultramafic Belt that trends N-S through the state. In certain areas, these ultramafics host talc carbonate rock developed by the alteration of serpentine bodies. The talc bodies are contained between footwall and hanging wall quartz mica schists, and are typically found within the noses of relict folds within the trend.

Talc alteration typically is strongest at the outer borders of the talc bodies and decreases gradationally inwards terminating rather abruptly at the boundaries of non-altered serpentinite. Within the talc bodies are found discontinuous bed-like lenticular bodies of chlorite and amphibole minerals, termed locally as "cinders", see sketch.



The ores vary in talc content and brightness based upon the degree of alteration and the percentage of other minerals present, particularly iron. These ore types are classified into A,B,C ores (rock types 10,20,30) based on talc content with attendant brightness estimates.

Deleterious minerals present in the bodies include arsenic sulphides, metallic arsenates, iron and fibrous minerals, principally tremolite and actinolite.



CYPRUS TALC OPERATIONS-VERMONT



APPALACHIAN ULTRAMAFIC TREND

Arsenic sulphides and arsenates encapsulated in talc grains are found in varying degrees from deposit to deposit and appear to be concentrated in the structurally distributed zones, shears and fractures according to Cyprus staff.

Fibrous amphiboles are noted in footwall and hanging wall zones and in grey talcs near these areas; they are also found within and bordering some of the "cinder" zones and at the contact zone with serpentine.

Ore Requirements

The desirable qualities of the ores include:

- 1) adequate tonnage
- 2) low stripping ratio and economic mineability
- 3) high talc content (for wet mills particularly)
- 4) talc quality
- 5) high brightness
- 6) low arsenic
- 7) zero fibres in ore to mill
- 8) proximity to mill

The reserves of the Cyprus Vermont talc deposits were reviewed in regard to the above.

Troy Mine

The Troy talc deposit is mined solely to provide ore to the Johnson Mill whose +70,000 ton ore requirement is made up of about 50,000 tons per year from

Troy and about 20,000 tons per year from the Hamm mine, see below. Troy ore recoveries and brightness are too low to be the sole raw material used. The Troy deposit is located some 15 miles from the Johnson mill and the cost of transporting the ore is estimated at \$12.00/ ton vs. \$26.00/ton for the Hamm ore.

The Troy orebody is a tabular body, some 140' thick striking N-S and dipping -45° to the west. The talc is contained in a highly variable mixture of talc, chlorite, magnesite, hematite, limonite, serpenite minerals and quartz veins and the reserve has been divided into four zones based on ore quality. The talc trend has been traced for some 2000' of strike length of which some 900' of strike length (the more northerly segment) has been tested with 8 drill holes on 5 sections, 50'- 150' apart. Given the 2000' apparent strike length and 150' thickness, the zone taken to a depth of 100' has yielded an "ore reserve" calculated by Cyprus at 3,030,000 tons - a number that needs modification in respect to the quality and nature of the talc as contained.

Experience with Troy ores in the Johnson mill has indicated that much of it is too low in talc or too low in brightness for reasonable recoveries of 84 GEB brightness product to be made. During 1991, a concerted effort took place to improve the quality of the Troy ores through selective mining. New reserve estimates have been made using the percentage of each ore zone estimated to be acceptable as mill feed.

Recent work in the Troy talc deposit has divided the ore reserve into 4 zones based on ore quality.

- Zone I - Hanging wall ore - high in talc content, but high in chlorite and Fe_2O_3 discolorant; perhaps 50% of this zone can be used as mill feed.
- Zone II - Ferric oxide stained zones; too discolored for mill feed; none of Zone II can be used for mill feed.
- Zone III - Moderate talc content - 45%-50% with manageable discolorant in the 65% GEB range; perhaps 80% can be used in mill feed.
- Zone IV - Footwall zone; reasonable talc content in some zones; high specular hematite content removable through magnetic separation; perhaps 50% of Zone III can be used as current mill feed.

Applying the usable percentages to the ore reserve, as it is delineated by the drill holes, yields an indicated mineable, usable reserve of 470,000 tons at a w/o ratio of roughly 1.0 to 1; additional inferred reserves could be perhaps 3 times this number at an increased waste/ore ratio.

An inspection of the stockpiles at the Troy Mine identified 67,000 tons of inventory; 59,000 tons are felt by mill staff to be unusable because of low talc content; quartz; poor color; with 13,000 tons of fines that can be used only when dry. The 8,800 remaining tons of "good ore" is of borderline quality, as current recoveries on Troy ore are around 25%.

At best, the ores from selected ore zones sent to the Johnson mill will average 45% - 50% talc and have a crude GEB of 68%, providing mill recoveries in the 25% - 30% range.

The Johnson mill needs higher grade, higher brightness ore to produce competitive products, and is currently using the Hamm ore for 30% of its mill feed to the floatation process inspite of Hamm's potential arsenic and fibre content problems.

Troy ore has some strengths. It is relatively low in average arsenic content, about 3 ppm, and contains no visible fibrous minerals but Hamm ores (with fibre and arsenic problems) are needed to provide the talc recoveries and brightness needed to produce selected products.

With its main source based in Troy ore, the Johnson mill is currently just getting by; a better, lower cost mill feed than the Troy ore, or the costly distant Hamm ore is needed. More selective mining at Troy was tried in 1991. Ore bleaching has been proposed. Some exploration along the northern Vermont exploration belt has been carried out. The problem remains. There is no known nearby good quality ore for the Johnson Mill.

The Hamm Mine

The data on the Hamm mine was accumulated by several companies over a broad time period and was recently summarized by CIM in a generalized computerized reserve that we can't really accept as a reliable basis for an accurate ore estimate.

Our review of the data summary yielded a 3,060,000 ton geologic reserve of talc ore with 2,700,000 tons of waste within the planned pit, but it will require

continued analysis of whatever fundamental base data we can get to properly evaluate the reserve. Our mineable ore reserve calculation to date yields 1,950,000 tons of mineable reserves to the 1600' level at a 1:1 waste to ore ratio.

The Hamm mine has established problems with high arsenic zones and areas with fibrous actinolite, but is mined for its relatively high talc content and high brightness ores.

Figures generated by Cyprus suggest that Hamm contains 1,080,000 tons of ore with a +75% GEB. Total +65% GEB reserves by the same survey indicate 2.5 million tons in reserve.

Of 1991's 104,000 tons of production, 18,000 tons were recorded as directed toward the Johnson Mill in northern Vermont and 38,000 tons were directed to West Windsor. Both of these wet mills had problems with Hamm's high arsenic ores. The balance of 104,000 tons were directed to Chester for dry milled high brightness industrial ores.

Hammondsville Mine

Hammondsville is a large but deep reserve mined underground in the past. A maze of underground workings are recorded on the mine plan and various reserves from 4 million tons to 7 million tons are on record. It is accepted, however, that the remaining reserve is too deep for open pit mining and current underground working too expensive for any economic recovery.

DRY GROUND BRIGHTNESS (Non-Floated)

	Overall	+75		(75-65)		-65		Mineable*
		% Mineable	Tons	% Mineable	Tons	% Mineable	Tons	Totals (000)
Hamm A	20	20	120	70	420	10	60	600
Hamm B	50	40	600	50	750	10	150	1500
Hamm C	30	40	360	40	360	20	180	900
Totals	100		1,080		1,530		390	3,000
Rainbow A	10	20	15	70	54	10	8	77
Rainbow B	50	40	153	50	192	10	38	383
Rainbow C	40	50	152	40	122	10	31	305
Totals	100		320		368		77	765
ARGMOB A	50	10	250	80	2000	10	250	2500
ARGMOB B	40	10	200	80	1600	10	200	2000
ARGMOB C	10	10	50	80	400	10	50	500
Totals	100		500		4,000		500	5,000
ARGEOB A	10	10	30	80	240	10	30	300
ARGEOB B	60	10	180	70	1260	20	360	1800
ARGEOB C	30	10	90	40	360	50	450	900
Totals	100		300		1,860		840	3,000
BLB A	10	10	13	80	104	10	13	130
BLB B	50	20	130	50	325	30	195	650
BLB C	40	30	156	50	260	20	104	520
Totals	100		299		689		312	1,300
TROY A	10	0	0	80	240	20	60	300
TROY B	10	5	15	80	240	15	45	300
TROY C	80	5	120	60	1440	35	840	2400
Totals	100		135		1,920		945	3,000

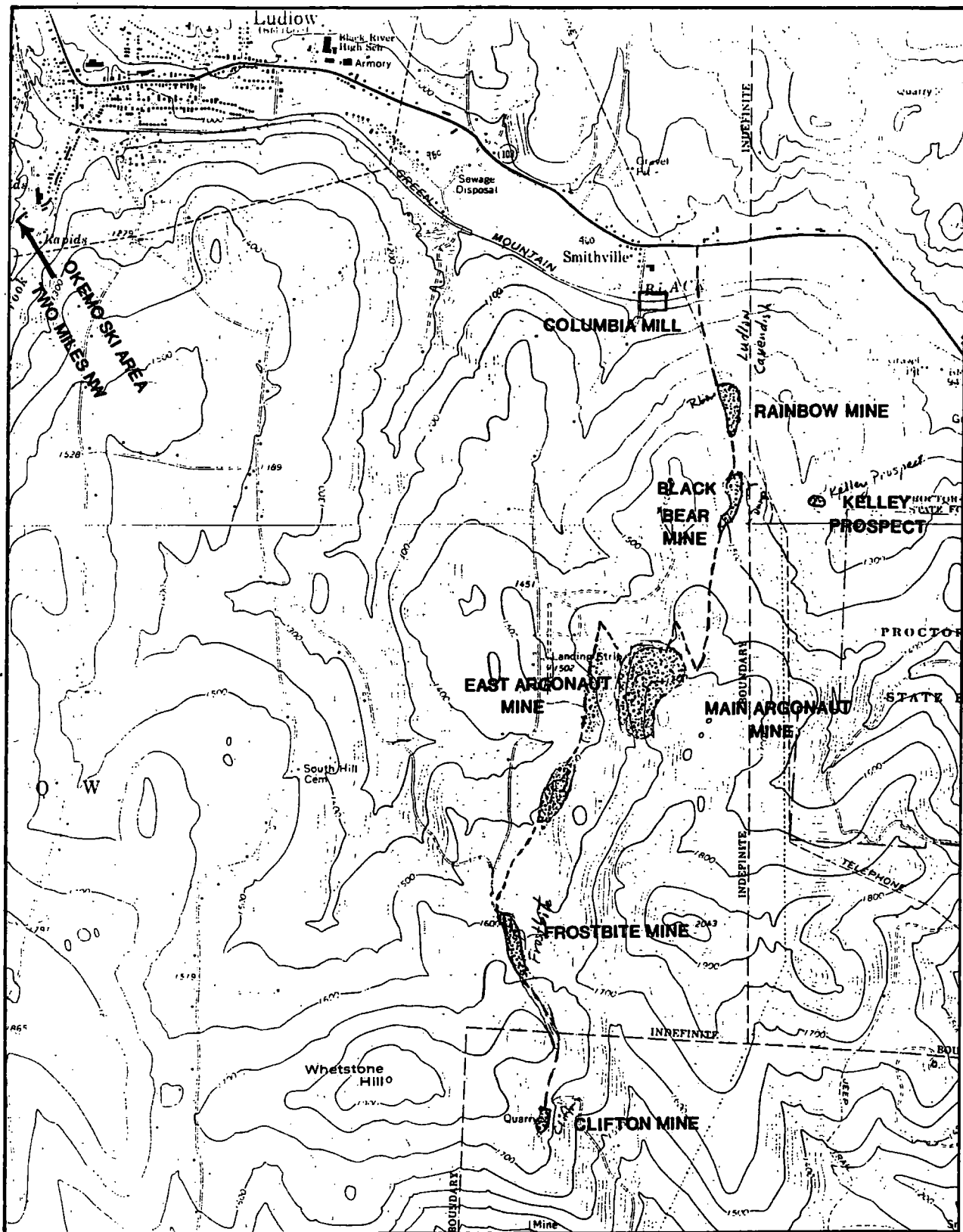
In addition, a good portion of the existing mine has been de-stabilized with pillar removal and economic re-entry to the mine is impractical. No one involved with the due diligence evaluation would accord Hammondsville any reserve value.

Ludlow Mines

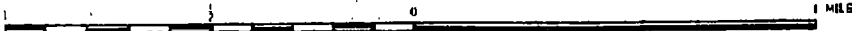
The Ludlow area talc mines extend southward from the Columbia Mill on a meandering trend of the altered ultramafic belt. The mines deposits are the Rainbow, Black Bear, Argonaut, Frostbite, Clifton and Kelly. The Ludlow mines are operated as a unitized project with development and mining moving from deposit to deposit to generate budgeted tonnages of the highest grade and brightest ores possible aimed principally at the dry industrial product mills (141,000 tons at Chester and Columbus) although small tonnages of ore (5,500 tons) do go to West Windsor and Johnson floatation production. Ludlow deposits vary as to content of high brightness and talc content. Most have significant arsenic and fibre bearing areas which must be excluded, see chart on page 31. These mines carry high royalties, the subject of a separate study.

Rainbow

The northwest mine, **Rainbow**, is pursued because of its relatively high brightness ore. About half (320,000 tons) of the estimated reserve of 765,000 tons is estimated at +75% GEB. The principal available current resource of high brightness material, the Rainbow is currently removing highwall waste material in preparation for future reserve access at obvious high cost - it must be something special that the mills want.



SCALE



TALC TREND

TALC DEPOSIT

CYPRUS LUDLOW AREA TALC OPERATIONS

Black Bear

Black Bear contains an accessible 300,000 ton reserve of + 75% GEB material. Mining was carried out in 1991. Total reserves are estimated at 1,300,000 tons mineable, of which 300,000 are estimated to be +75% GEB and 700,000 at +65% GEB. With most of its ore directed for Columbia and Chester, Black Bear provides a viable future reserve of high brightness material for industrial products.

Argonaut

The most important reserve on the Ludlow trend is the Argonaut where the Argonaut Main ore body open pit, a three million ton deposit of medium (> 65-75 GEB) brightness reserve, has been supplanted by the development of the Argonaut East ore body due to the high stripping ratio and possibly high incidence of fibre bearing zones encountered at the main ore body.

The Argonaut East ore body offers a potential of 3 million to 5 million tons of material that is in the inferred category. Of the eight drill holes directed to it in 1988, only four can be used to estimate the reserve. They, with past mapping in older underground workings, suggest a substantial mineable tonnage here averaging perhaps 20% +75 GEB material. The deposit is currently being developed with stripping and mining of shallow ore. The extension of the Argonaut mining permit for this work has been protested by a nearby homeowner and supporters. The development would be within view of the Okemo ski area, some 4 miles distant.

The Argonaut East ore body presents good potential for a high tonnage of medium to high brightness reserves of Ludlow type ore.

Alpine Alabama

The Alpine deposit is a small zone of talc quartzite whose saprolite reserve was mined by open pit in the past. Current reserve is in hard rock. CIM ore reserve calculation shows a mineable reserve of 75,000 tons in a remaining 100' depth - 80% of this is +80 GEB # 1 ore. The waste to ore ratio is calculated at 5:1.

An independent cross section manual on reserve calculation supports these reserve numbers.

Alpine ore goes to Alpine Mill stockpiles where it is used to produce 3,600 tons of Regal, Act II, Alphafil and YB products using # 1 ore, 33%; # 2 and # 3 ore (40-80% GEB) 33%, see Anderson's chart page 36. Recovery is given at 70%; so ore requirement then will be 3,445 tons per year.

Alpine was campaign mined in 1991 (21,000 tons) and (by inspection) there is at least that tonnage (estimated at +30,000 tons) on the stockpile.

The next mine campaign is planned for 1996. However, pit is flooded and the future accessibility of new ore is impossible to estimate.

The Alpine ore isn't perfect; it needs bleaching and has a high quartz content in some areas. The Alpine mill has and could run without Alpine ore, whose main value is its apparent low cost (given at \$30/ton).

From

Drew Anderson, John Close,
Brychan Griffiths

Date February 14, 1992

To

E. H. Reade

Subject Crude Required to Produce Finished Goods

CIMC PRODUCT LINE	Fin. Goods 1991 TOTAL TONS	CRUDE No. 1	CRUDE No. 2	CRUDE No. 3	CRUDE No. 4	\$ VALUE
Regd'l, Act II, Alpha Fil YB	3600	Alabama #1 33% @ \$30/ton	Alabama #2 17% @ \$30/ton	Alabama #3 17% @ \$30/ton	Australian Fines (stained) 33% @ \$95/ton	
Altalc	2600	Beaverhead #A grade 100% @ \$175/ton				
Supra Suprafino	2100	Italian 50% at \$282/ton	Australian Cosmetic @ \$147/ton			
Supra EFA	200	Italian 75% at \$282/ton	Beaverhead 25% @ \$175/ton			
Top Note Brilliant Alphaglide	180	Italian 100% at \$282/ton				
Aura Stellar	260	Austr. Cosm. 100% at \$147/ton				

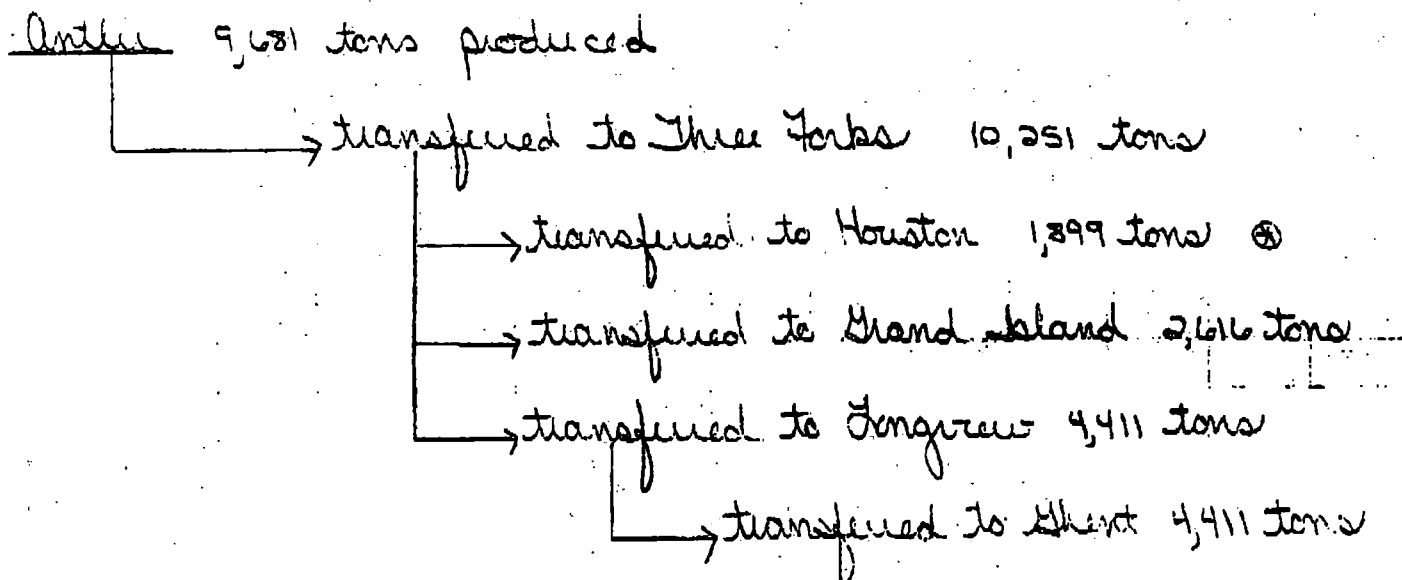
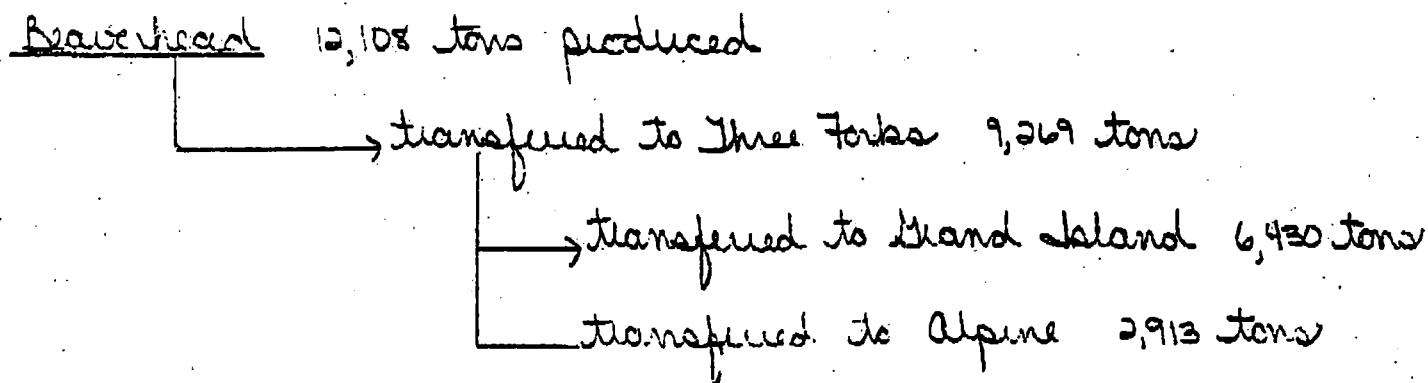
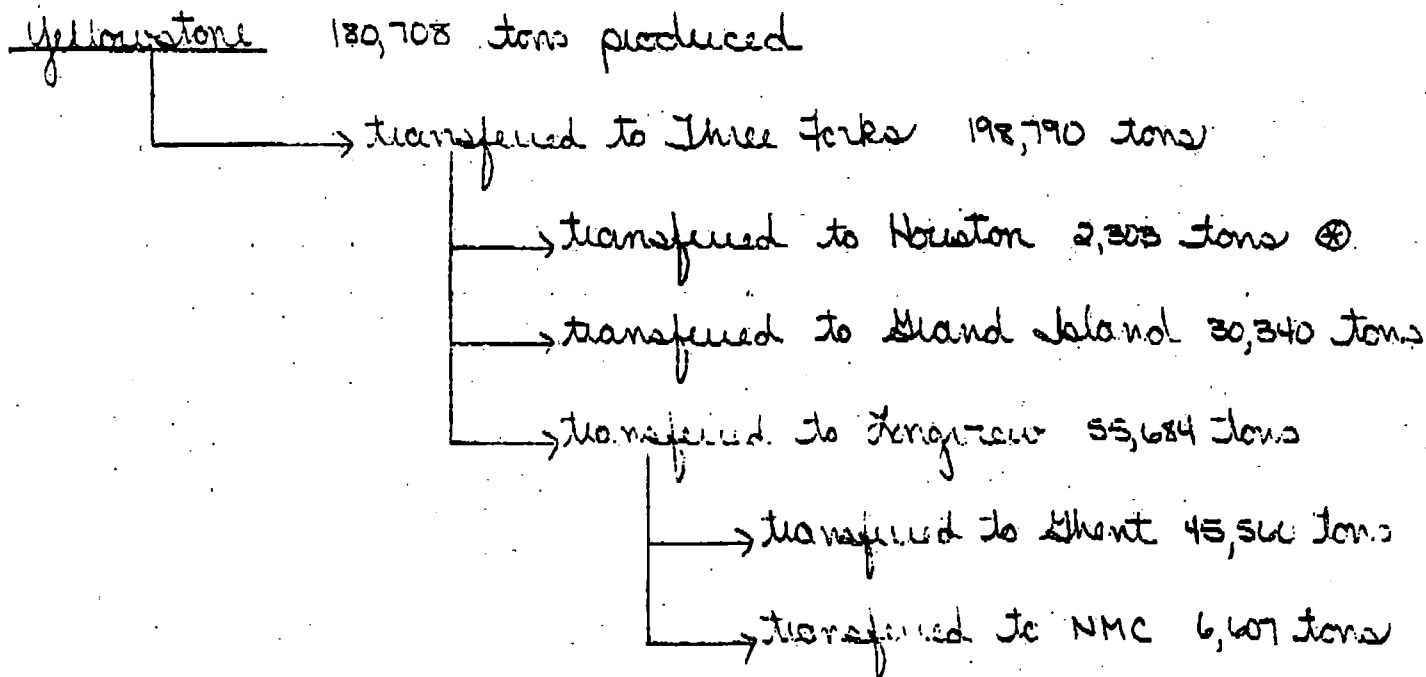
NOTE: Crude blends should show origin, percent & value per ton.
 Ex.: 20% BVHD @ \$125/T.

PLEASE FAX RESULTS TO YELLOWSTONE ON 2/17.

cc: R. D. Baker
 F. F. Beyl
 M. J. Lorang
 B. Wright

DL
 2-15-92

CYPRUS



* ultimately shipped into Mexico.

Hammontonville 351 tons produced

→ transferred to West Windsor 351 tons

Hudlow 147,838 tons produced

→ transferred to Columbia 141,086 tons

→ transferred to Chester 5,573 tons

→ transferred to West Windsor 5,658 tons

Hamme 103,927 tons produced

→ transferred to Chester 103,927 tons

→ transferred to Johnson 18,191 tons

→ transferred to West Windsor 37,533 tons

Joy 45,675 tons produced

→ transferred to Johnson 51,090 tons

Red Hill/Male City 15,289 tons produced
→ transferred to Toyon 15,289 tons

Alpine Mine 21,062 tons produced
→ transferred to Alpine Mill 902 tons

Malaga Mine 0 tons produced
→ transferred to Malaga Mill 0 tons
→ transferred to Ghent 2,496 tons